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PHYSICS ABSTRACTS

SECTION A

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SCIENCE ABSTRACTS

SECTION A, PHYSICS

SECTION B, ELECTRICAL ENGINEERING

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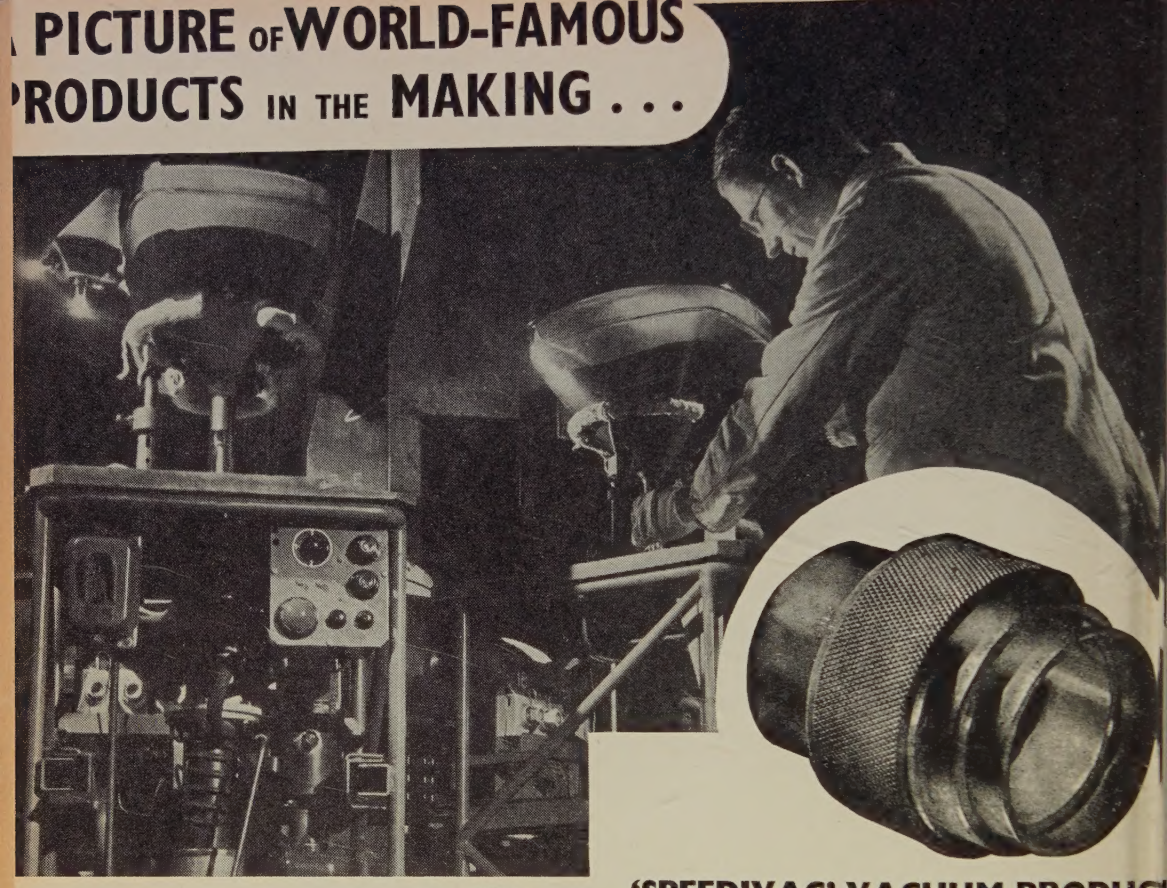
VOLUME 58 **OCTOBER 1955** NUMBER 694

A PICTURE OF WORLD-FAMOUS PRODUCTS IN THE MAKING . . .



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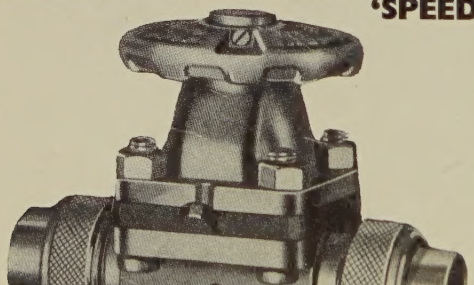

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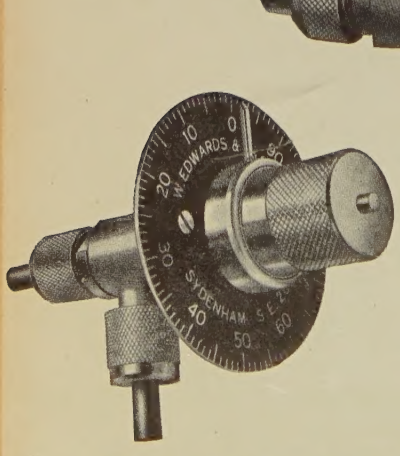

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RELATED SUBJECTS CONTAINED IN SECTION B (ELECTRICAL ENGINEERING ABSTRACTS)

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Electronic relays and counters
Automatic control mechanisms
Applied electrochemistry
Lines and networks
Waveguides
Photocells
Thermionic tubes
Cathode-ray tubes
X-ray tubes
Oscillators. Pulse circuits
Amplifiers
Electroacoustic apparatus
Radiocommunication
Mechanical engineering
Illumination

LIST OF JOURNALS

The following list supplements the List of Journals published with the January number of Volume 56 (1953) and the Supplements published with the Indexes to Volumes 56 (1953) and 57 (1954). Reprints of the List of Journals (1953) and the Supplements (1953 and 1954) can be obtained from The Institution of Electrical Engineers, Savoy Place, London, W.C.2, price 2s. 0d. post free.

The addresses given are believed to be correct at the date of publication, but no responsibility can be accepted for errors.

J. Radio Res. Lab. [*Tokyo*] — *Journal of the Radio Research Laboratories.* The Radio Research Laboratories, Ministry of Postal Services, Tokyo.

New Journal

E T J Japan — *The Electrotechnical Journal of Japan.* The Institute of Electrical Engineers of Japan (The Denki-Gakkai), Yuraku-cho, Chiyoda-ku, Tokyo.

The overseas edition (selected and abridged) of the Journal of the Institute of Electrical Engineers of Japan, published monthly in Japanese. Quarterly. Volume 1, Number 1 dated March, 1955. Subscription per year: 1,000 yen (approximately U.S. $3.00) postage included.

Erratum

Abstr. 5552 (1955) line 2: *for* H. PREUSZ *read* H. PREUSS

Corrections to Articles

Corrections have been published, as shown below, to the articles whose abstract numbers are given. Unless otherwise stated, the volume and page given refer to the journal named in the abstract, i.e. the journal in which the original article was published.

Abstr. 2189 (1955): **33,** *No.* 8, 492 (*Aug.*, 1955).

Abstr. 2586 (1955): **23,** *No.* 8, 1559 (*Aug.*, 1955).

Abstr. 4369 (1955): **16,** *No.* 3–4, 192 (1955).

Abstr. 6708 (1955): **241,** *No.* 1, 136 (*July* 4, 1955).

Abstr. 6808 (1955): **10,** *No.* 7, 593 (*July*, 1955).

MATHEMATICS 51

515 : 535.317

Optical transformation of the general quadrilateral into a parallelogram. *See Abstr.* 7812

517.512.2

7616. Convergence and summation of a Fourier series corresponding to an analytic function. R. CAZENAVE. *Ann. Télécomm.*, **10**, *No.* 5, 102–8 (*May*, 1955) In French.

The Fourier series representing a given homomorphic function is related in a simple way to a power series, and a study of the latter (especially on its circle of convergence) leads to properties of the coefficients of the Fourier series and to results about its convergence. Use is made of the Poisson integral and a vectorial diagram for a Fourier series is described.

L. S. GODDARD

518.42

7617. The smoothing of unformulated experimental laws. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1866–8 (*May* 9, 1955) In French.

When the physical relation between the quantities measured is unknown the principle of regularity is of no help in the process of smoothing the curve of the experimental data. Taking a constant experimental interval each ordinate must be replaced by the arithmetic mean of its neighbouring ordinates after subtracting from the more crude values the differences between these values and the corresponding values calculated from the algebraic relation which gives as nearly as possible the same general curve as the experimental points. The effect of this smoothing process is very limited. S. WEINTROUB

518.42

7618. The differentiation of experimental curves. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 22, 2124–5 (*June* 1, 1955) In French.

The first and second derivatives are obtained by taking the first and second differences respectively of the ordinates corresponding to equidistant neighbouring abscissae and then smoothing in accordance with the method of the preceding abstract. The particular difficulties and inaccuracies introduced are discussed. S. WEINTROUB

518.5

7619. The electromagnetic delay line as a source of relations between Bessel functions and elliptic integrals. P. M. PRACHE. *Ann. Télécomm.*, **10**, *No.* 4, 82–6 (*April*, 1955) In French.

Infinite integrals of products of Bessel functions are reduced to readily calculable elliptic integrals by comparison of two differently derived expressions for the magnetic flux in a helix. The results are readily extended by F transformation. A. H. W. BECK

518.5 : 519.2

7620. Machine testing for deviation of data from a Poisson distribution. F. A. HADDEN. *Trans Amer. Inst. Elect. Engrs I*, **74**, 155–7 (1955) = *Commun. and Electronics*, *No.* 18 (*May*, 1955).

A practical card machine method is described for separating data affected by special events which otherwise are Poisson distributed. This is illustrated with reference to valve failures in aircraft; a Gaussian distribution is used as a basis for approximating to Poisson. T. J. REY

518.5 : 655.3

7621. Electronic computer for color printing. H. E. ROSE. *Trans Amer. Inst. Elect. Engrs I*, **74**, 268–72 (1955) = *Commun. and Electronics*, *No.* 18 (*May*, 1955).

Describes an electronic computer for solving three 4th-degree simultaneous equations in $<50\mu$sec, to establish the four ink values of colour printing required to match the colour of the original picture. Multiplication is by pulse width modulation and 1% accuracy is claimed. On–off operation is used extensively for accuracy which is claimed to remain within 2·5% during the cycle of operations required in producing the colour-corrected plates of a subject. T. J. REY

519.2

7622. Remarks on the foundation of probability calculus. L. JÁNOSSY. *Acta phys. Hungar.*, **4**, *No.* 4, 333–49 (1955).

The addition and multiplication axioms of probability calculations are deduced from a number of qualitative assumptions about the way of composition of independent and of excluding events. It is shown that from these assumptions a somewhat generalized addition and multiplication rule can be derived. It turns out, however, that this generalization corresponds only to a possible deformation of scale of probability and thus the generalized scheme does not lead to any results differing from those obtained in the usual way. Furthermore, the ordinary addition and multiplication rules are contained as specialized cases of a more generalized scheme. A.

519.2

7623. A solution of some problems of K. Borsuk and L. Jánossy. J. ACZÉL. *Acta phys. Hungar.*, **4**, *No.* 4, 351–62 (1955).

The aim of the present paper is the determination of those continuous strictly monotonic and associative operations for which addition (problem of A. Gruzewski–K. Borsuk), multiplication or the quasimultiplication $\psi^{-1}[\psi(x)\,\psi(y)]$ are distributive; further the determination of those operations which are distributive for addition or the quasi-addition $\psi^{-1}[\psi(x)+\psi(y)]$. The respective operations are

$$a\log(a^x+a^y),\ \sqrt[k]{x^k+y^k},$$
$$\psi^{-1}\left[\sqrt[k]{\psi(x)^k+\psi(y)^k},\right]cxy,\ \psi^{-1}[c\psi(x)\psi(y)].$$

From this it is derived that the probability of the occurrence of one of two exclusive events of both of two independent events has the form $\psi^{-1}[\psi(p)+\psi(q)]$ or $\psi^{-1}[\psi(p)\psi(q)]$ as was suggested by Jánossy (preceding abstract) if we suppose only that the probability of (A or B) increases continuously with the probabilities of A and B, and the probability of the

occurrence of one of three events does not depend on their arrangement; further the non-negative probability of the simultaneous occurrence of two events does not depend on their order; and finally the probability of (A or B) and C equals that of (A and C) or (B and C). On the other hand by modifying a theorem of S. Golab it can be seen that the same formulae are valid (the second even for non-independent events) if besides this last condition these probability functions are derivable (the second with respect to its second variable in a continuous manner) the first being also strictly monotonic; and if the probability of A or the impossible event, and of A and the certain event (without regard to their order), is equal to the probability of A; and finally the simultaneous occurrence of any event with the impossible event is also impossible. Further similar statements are also proved. A.

ASTRONOMY . ASTROPHYSICS . GEODESY 52

523.11 : 530.12

7624. Perturbed cosmological models. A. RAYCHAUDHURI. *Z. Astrophys.*, **37**, *No.* 2, 103–7 (1955).

The gravitational equations are integrated for a distorted cosmological model under the assumptions that even after the distortion (i) the model exhibits spherical symmetry about some point and permits a comoving system of co-ordinates, (ii) the pressure is isotropic and (iii) the boundary conditions given by O'Brien and Synge (1952) are obeyed. The behaviour of the distorted model is discussed and in particular the possibility of condensations of the type observed in the actual universe is examined. A.

523.11 : 530.12

7625. The cosmical constant and the classical limit of Einstein's field equations. A. SCHLÜTER. *Astron. J.*, **60**, *No.* 4, 141–3 (*May*, 1955).

It is shown that Newtonian homogeneous models for the universe with an extra radial force per unit mass $\frac{1}{3}\lambda r$ (where the point $r = 0$ is arbitrary) resemble closely solutions of Einstein's equation for the same models with the λ term. A.

523.112

7626. The theoretical aspects of the nebular redshift. H. P. ROBERTSON. *Publ. Astron. Soc. Pacific*, **67**, 82–98 (*April*, 1955).

In a review of cosmologies based on the metric $ds^2 = dt^2 - T^2(t)du^2$, a special investigation is made of the extent to which theoretical parameters may be determined from astronomical observations. Theoretical relations between red-shift, angular diameter and apparent magnitude are considered, and the concept of spatial distance is discussed. R. A. NEWING

523.162.2

7627. Observable tests on the nature of the cosmological red shift. S. N. MILFORD. *Astrophys. J.*, **122**, *No.* 1, 13–23 (*July*, 1955).

Develops tests on the red shift in the spectra of distant galaxies, in order to distinguish between the Doppler velocity interpretation of the red shift and some other cause. Section I discusses the previous tests proposed by McCrea and by Hubble and Tolman. Section II sets up new theoretical tests in a non-static relativistic cosmological model; section *a* describes the cosmological model used; *b* finds the equation for the time rate of variation of brightness of a star in the model universe employed; and *c* discusses the observed frequency of distant events in the same model. In Section III the tests are cast into their observable form. The most promising test expresses the rate of decline of the light-curve of a distant supernova in terms of the red shift in its spectrum and an equation is given. This supernova test is probably free from the evolutionary objections to the galaxy counts test. In Section III, c, the test on the frequency of novae and supernovae is discussed. Finally, there is a brief discussion of the practicality of the tests, and it is concluded that the supernova light-curve test could be carried out with existing equipment. A.

523.162.2

7628. Some evidence for a regional variation in the law of interstellar reddening. H. L. JOHNSON AND W. W. MORGAN. *Astrophys. J.*, **122**, *No.* 1, 142–5 (*July*, 1955).

Observations of the colours of early O stars on the (*U*, *B*, *V*) system indicate that the reddening law may be appreciably different in a region in Cygnus ($40° < l < 50°$) from that found for northern galactic longitudes $>70°$. The deviation is in the sense that relatively more ultraviolet light is absorbed in the Cygnus region. A possible explanation in terms of the distance of the absorbing material from the O star is suggested. A.

523.164

7629. On the mechanism of superthermal cosmic radiofrequency radiation. R. W. LARENZ. Letter in *Naturwissenschaften*, **42**, *No.* 9, 253–4 (1955) In German.

In a qualitative discussion of the significance of charge separation by currents in an ionized gas, it is suggested that longitudinal "sound" waves propagated in a direction inclined to the general drift motion of the plasma might generate a combined transverse-longitudinal electromagnetic wave and give rise to a radiation current with observed intensities without the assumption of implausibly high temperatures.

R. A. NEWING

523.164

7630. Observations of a variable radio source associated with the planet Jupiter. B. F. BURKE AND K. L. FRANKLIN. *J. geophys. Res.*, **60**, *No.* 2, 213–17 (*June*, 1955).

A source of variable 22·2 Mc/s radiation has been detected with the large "Mills Cross" aerial of the Carnegie Institution of Washington. The source is present on nine records out of a possible 31 obtained during the first quarter of 1955. The appearance of

the records of this source resembles that of terrestrial interference, but it lasts no longer than the time necessary for a celestial object to pass through the aerial pattern. The derived position in the sky corresponds to the position of Jupiter and exhibits the geocentric motion of Jupiter. There is no evident correlation between the times of appearance of this phenomenon and the rotational period of the planet Jupiter, or with the occurrence of solar activity. There is evidence that most of the radio energy is concentrated at frequencies lower than 38 Mc/s. A.

523.164

7631. An alternative identification of the radio source in the direction of the galactic centre. R. D. DAVIES AND D. R. W. WILLIAMS. Letter in *Nature [London]* **175**, 1079–81 (*June* 18, 1955).

The distance of source 1752*A* in the I.A.U. list has been determined to be about 3 k.parsec by two methods: (i) from the equivalent width of the interstellar hydrogen absorption line of the source, and (ii) from the amount of absorption of the radiation of the source by interstellar hydrogen at the centre of the hydrogen line emission spectrum. The spectrum of this source, found by combining published data at different frequencies, is flatter than for other sources, suggesting an origin in a region of optically-thin gas. The extent of the region, whose angular diameter is about 1°, is about 50 parsecs at 3 k. parsec. The source is provisionally identified with a nebulosity supposed associated with a group of early-type stars reported at the correct distance in the direction of the source, this nebulosity being invisible on optical wavelengths due to the heavy obscuration of the region.

M. W. OVENDEN

523.164

7632. The radio position of the galactic nucleus. J. D. KRAUS AND H. C. KO. *Astrophys. J.*, **122**, *No.* 1, 139–41 (*July*, 1955).

Recent positions obtained by five different groups of observers are averaged to give a most probable position of the nucleus of $l = 327{\cdot}79°$ and $b = -1{\cdot}39°$. A map showing the individual and average positions is included. A.

523.164

7633. A note on the galactic microwave spectrum. A. E. LILLEY. Note in *Astrophys. J.*, **122**, *No.* 1, 197–8 (*July*, 1955).

The possibilities of detecting microwave spectral lines other than that of H I are discussed. Interest is centred on the OH line at 1 668 Mc/s, and the deuterium line at 327 Mc/s, since both of these should give just-detectable signals with existing equipment of sensitivity ~1 deg. K. It is suggested that a large aerial pointed at an intense discrete source should improve the likelihood of detecting new emissions in the galactic microwave spectrum. D. R. BARBER

523.164 : 551.510.535

Radio star scintillations due to ionospheric focusing. *See Abstr.* 8423

523.164 : 621.396.9

7634. Radio-astronomy. S. É. KHAĬKIN. *Radiotekhnika*, **10**, *No.* 4, 7–25 (1955) In Russian.

A survey dealing with the origin and sources of cosmic radiation, the methods of its measurement and the radiation properties of various cosmic sources. The measurements at radio frequencies are carried out by means of radio-telescopes, either directly or indirectly, the object being to determine: (1) power of the received radiation, (2) co-ordinates and dimensions of the source, (3) distribution of the intensity of radiation over the surface of a source, and (4) degree of polarization and spectral distribution in the radiation. Since the spectrum of cosmic radiation is very broad and the time factor is of no consequence in the measurements, the radio-telescope receivers can have a large bandwidth and a long time constant, thus achieving a sensitivity of ~1 deg. K. The experiments carried out over the last decade show the temperatures of the sun are $\sim 10^{6}$ °K and 10^{5} °K on m- and cm-wave lengths, respectively, the periods of heightened solar activity being accompanied by a 1 000-fold increase in the temperature on m-waves. Radiation of the Galaxy has the form of a background noise, interspersed with maxima due to stronger discrete sources; up to now 2 000 discrete sources have been observed. Interstellar hydrogen radiates a line of ~21 cm, its intensity being dependent on the direction of the observation. R. S. SIDOROWICZ

523.165 : 532.51 : 537.591.1 : 538.56

7635. Hydromagnetic waves and the acceleration of cosmic rays. E. N. PARKER. *Phys. Rev.*, **99**, *No.* 1, 241–53 (*July* 1, 1955).

The large amounts of energy necessary for the acceleration of cosmic rays throughout the Galaxy introduces a serious transport problem. The hydrodynamic and hydromagnetic equations are investigated from the viewpoint of energy propagation. It is shown that, with the galactic model of Fermi and Chandrasekhar, the observed motions of the interstellar gas reduce to hydromagnetic waves, which are, as it turns out, the most effective means of energy transport. A consideration of the interaction of charged particles with hydromagnetic waves shows that it is the fluid velocity, and not the wave velocity, that is responsible for the acceleration of cosmic rays by Fermi's mechanism. Calculations are made of the dissipation of hydromagnetic waves in the interstellar medium, and the variation of amplitude and wavelength of such waves with changes in density and large-scale field intensity. It is then shown that the Galaxy is no more than 1% efficient in the acceleration of cosmic rays because of the tremendous viscous losses in the interstellar medium, and that there is no hydromagnetic mechanism that can convert the observed large-scale low-velocity fluctuations in the interstellar medium to the required small-scale high-velocity motions. A.

523.2 : 538.12

7636. On an interplanetary magnetic field. A. BEISER. *J. geophys. Res.*, **60**, *No.* 2, 155–9 (*June*, 1955).

Considerations suggesting the existence of an interplanetary magnetic field are presented. Such a field would not exceed about 5×10^{-8} gauss, and its presence can explain the observed cutoff in the primary cosmic-ray momentum spectrum. A field existing within the earth's orbit can account for all or part of the observed solar-terrestrial time delays in aurorae and magnetic storms. The time required for the

formation of a magnetic field pervading the solar system is less than 10^3 years, and its lifetime against decay is probably more than 10^{10} years. A.

523.2 : 538.12

7637. Solar-terrestrial time delays. A. BEISER. *J. geophys. Res.*, **60**, *No.* 2, 161–4 (*June*, 1955).

See also preceding abstract. The observed delay of about 24 hours between the meridian passage of a sunspot or flare and the onset of an associated magnetic storm or aurora is shown to originate in the magnetic deflection of the ion streams involved. If a solar magnetic dipole is exclusively responsible, its moment must be between 6×10^{27} and 10^{29} gauss cm^3. If an interplanetary magnetic field is involved, its magnitude is about 4×10^{-8} gauss. Should both fields act, which is likely, then the above figures represent maxima. A.

523.4 : 523.877

7638. The effect of exchange potential on the mass-radius relation for cold bodies. M. S. VARDYA. *Proc. Nat. Inst. Sci. India*, **21**, *No.* 1, 70–81 (*Jan.*, 1955).

The relationship has been calculated on the theory of pressure-ionization, taking into account the exchange potential of the electron. The theory has been developed for zero temperature as well as for non-zero temperatures. A.

523.6

7639. Comet outbursts. C. WHITNEY. *Astrophys. J.*, **122**, *No.* 1, 191–5 (*July*, 1955).

Several comet outbursts accompanied by the ejection of spherical halos are investigated. Special attention is paid to the mass and energy ejected in a typical halo. On the basis of the results, it is suggested that the energy of an outburst may be derived from normal insolation. The activity can possibly be explained in terms of the icy-conglomerate comet nucleus. A.

523.7

7640. The Sun. Edited by G. P. KUIPER. *Chicago: University of Chicago Press; London: Cambridge University Press* (1953) *xix* + 745 *pp.* [*The solar system, Volume I.*]

Review in *Nature* [*London*] **176**, 5 (*July* 2, 1955). "The solar interior, the photosphere, and the chromosphere and corona are each discussed with thoroughness in a chapter contributed by an acknowledged leader in the field. These chapters are primarily concerned with the quiet Sun. . . . In contrast, Chapter 6 deals with the observable transient disturbances in the solar atmosphere, and with their terrestrial effects. . . . The next chapter is devoted to an observational and theoretical discussion of solar radiation at radio wavelengths. . . . Chapter 8 is entirely theoretical and comprises a critical review of recent work in solar hydromagnetics."

523.72

7641. Observations of polarization of solar radio bursts. T. HATANAKA, S. SUZUKI AND A. TSUCHIYA. *Proc. Japan Acad.*, **31**, *No.* 2, 81–7 (*Feb.*, 1955).

A pair of crossed dipoles have been attached to a 10-metre paraboloid. Suitable phase-retardations and an electronic switch have been introduced to record successively six components of polarization of the received signal. When observing solar noise bursts, the switching cycle takes about 1/200 sec. Observations during December 1954 and January 1955 are reported and analysed. The polarization of noise bursts is in general a mixture of elliptically-polarized and randomly-polarized components. The ellipticity of the polarization ellipse decreases with increasing distance of the associated sunspot from the centre of the disk; this is interpreted in terms of the pattern of magnetic field surrounding the spot. The orientation of the polarization ellipse suffers changes, supposed due to Faraday effect in the earth's ionosphere. The degree of polarization varies from 85% to about 10%, in a somewhat irregular fashion.

M. W. OVENDEN

523.72

7642. Remarks on the solar radio radiation on 10 cm. B. VAUQUOIS. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1862–4 (*May* 9, 1955) In French.

The total emission from the sun at any time on a given wavelength is represented by the equation $F = k\Sigma A\phi(\theta) + F_0$ where F_0 is the base emission of the quiet sun, A is the true area of a sunspot, θ is the angular distance of the spot from the centre of the disk, and $\phi(\theta)$ the darkening function, k being a constant. The nature of $\phi(\theta)$ is found in two ways, using published observations on 2800, 3260 and 3750 Mc/s: (i) daily observations before, during and after the passage of an individual spot to give F_0 and $\phi(\theta)$ directly, and (ii) the representation of $\phi(\theta)$ by a set of discrete values $\phi(\theta_i)$, each daily observation yielding an equation of condition, these equations being solved for F_0 and $\phi(\theta_i)$ by least squares. The theoretical darkening function, based on de Jager's model corona and chromosphere, for various heights of origin of activity, do not correspond closely to the observed function; it is suggested that absorption by higher levels is not solely responsible for the darkening.

M. W. OVENDEN

523.746

7643. The rhythm of the zonal wandering of sunspots. W. GLEISSBERG. *Z. Astrophys.*, **37**, *No.* 2, 108–13 (1955) In German.

The epochs when sunspots attain an average distance of 15 deg. N or S of the sun's equator are found to follow one another with great regularity at, or close to, the successive epochs of maximum spot activity. Moreover, sequential coincidences of these two epochs appear to be in phase with the 80-yr spot cycle.

D. R. BARBER

523.755 : 523.59

7644. Fraunhofer corona and zodiacal light. H. ELSÄSSER. *Z. Astrophys.*, **37**, *No.* 2, 114–24 (1955) In German.

Using the zodiacal-light measures of Behr and Siedentopf (1953), and the usual model of dust-distribution in the planetary system, the brightness of the F-corona is computed, and a value of $\sim5\times10^{15}$ cm^{-3} is obtained for the number density of dust particles. Computation of the colour-excesses of the F-corona, and of an interpolated distribution between that of the zodiacal light and that of a solar corona, using successive electron-density values for the outer coronal regions, leads to a mean value close to that observed by Blackwell (1952). D. R. BARBER

523.76 : 538.12

7645. The magnetic field of the sun. M. WALDMEIER. *Naturwissenschaften*, **42**, *No.* 6, 149–51 (1955) In German.

Critical survey of the new researches into solar magnetism and their latest instrumental advances connected with the design of Babcock's magnetograph. The aspects of Hale's original pioneering work are discussed, as well as subsequent work, particularly by von Klüber, which convinced the observers that the general field of the sun is very small, at the most a few gauss. The production of the powerful new Babcock grating coupled with ingenious electronic devices has now made possible the continuous measurement of very small Zeeman-effects, and led to the recording of magnetograms representing a complete and practically simultaneous picture of the sun's magnetic situation. A solar image of about 40 cm is fully scanned along 19 parallel and equidistant strips within about 50 minutes, the result being shown and photographed on an oscillograph screen. Until now some 3–400 magnetograms have been secured. They indicate that only the polar regions, in latitudes beyond 60° latitude, have a noticeable field of 1–2 gauss; this fluctuates in extent and intensity. At lower altitudes numerous local bipolar fields are found, mainly connected with large regions of faculae. Unipolar fields have also been recorded, but remain hitherto unconnected with optically observed phenomena; it is suspected that these fields are related to the "*M*-regions" of the terrestrial magnetic storms. Various other relations are investigated, involving prominences, and corona-streamers, etc.; fluctuations of 1 gauss and a periodicity of some 30 minutes are indicated. Differential velocities of the order of 100 m/sec have been measured; kinematically uniform regions reach diameters of some 15 000 km. The author of this survey concludes by saying that the magnetograph has transformed the scene of solar-magnetic research with "results, the fruitfulness of which can be placed alongside optical observations in astronomy in the same manner as that of radio astronomy." A. BEER

523.77

7646. Comment on the Stark broadening of Hα in the sun. L. DOHERTY AND L. H. ALLER. *Stellar Atmospheres Conference* [*Indiana*] 98–100. See Abstr. 7656 (1955).

The observed Stark profile for Hα has been compared with a profile computed by means of a model solar atmosphere for which log (H/metals) = 3·4, and He/H = 0·05, using (*a*) the theory of statistical fluctuation of inter-atomic electric fields [Holtsmark and Verweij (1936)]; and (*b*) the multiple collision phase-shift theory of Kolb (1954). The former theory gave a too shallow profile; and the latter was found to be invalid out in the wings where the predicted absorption coefficient was too large. Neither of the computed curves fits the line-core, which originates in the uppermost regions of the solar atmosphere. D. R. BARBER

523.77

7647. On the influence of temperature inhomogeneities in the solar photosphere on the profiles of the hydrogen lines; with special reference to Hα. C. DE JAGER. *Stellar Atmospheres Conference* [*Indiana*] 108–18. See Abstr. 7656 (1955).

In a detailed discussion of observations associated with macro-turbulent, and micro-turbulent features of the undisturbed solar photosphere, and low chromosphere, it is demonstrated that, in addition to classical Stark and Doppler effects, there are manifest: (i) temperature inhomogeneities of the whole photosphere of the order of ±800 to ±1 000°K; (ii) a widening of the inner part of line-profiles (especially Hα) by slow, large-scale motions and temperature inequalities in the upper part of the photosphere amounting to ±0·02 and 0·06 Å respectively, at 0·45 Å from the line centre; (iii) the light distribution in the line-core is modified by the presence of bright and dark mottlings which contribute to a mean intensity fluctuation, $\Delta I/I$, of ±10%. It seems probable that these same effects also play a rôle in stellar atmospheres. D. R. BARBER

523.775

7648. Various relationships between Fe X and Fe XIV emission in the minimum corona. W. PETRI. Note in *Naturwissenschaften*, **42**, *No.* 5, 119 (1955) In German.

Observations of the coronal emission lines λ6374 Å (Fe X) and λ5303 Å (Fe XIV) made at Freiburg i. Br. during the period of low solar activity, 1953/54, are discussed. The coronal electron temperature was systematically lower in the southern hemisphere than in the northern. Emission in both lines, but especially the red line, was enhanced above sunspots. Regions of enhancement of the green line above spot-free regions were flanked by enhancement of the red line. The statistical correlation between enhancement of the red and green lines is thus due to their individual correlations with sunspots, the enhancement in this case being supposed due to locally high electron densities. Above spot-free regions, the enhancement is supposed due to locally high electron temperature, the difference in behaviour of the two lines indicating lateral temperature gradients. M. W. OVENDEN

523.851

7649. On stellar statistics. A. RAMAKRISHNAN. *Astrophys. J.*, **122**, *No.* 1, 24–31 (*July*, 1955).

The problem of the distribution of stellar intensities when the interstellar matter consists of (1) discrete clouds, and (2) a wildly fluctuating density field is formulated in a general manner from a stochastic point of view, and some results are obtained in particular cases. A.

523.855 : 530.12

7650. Relativity and the statistical theory of the distribution of galaxies. G. C. MCVITTIE. *Astron. J.*, **60**, *No.* 4, 105–15 (*May*, 1955).

The statistical theory of galaxy-clustering due to J. Neyman and his co-workers presupposes that the galaxies are at mutual relative rest in the Euclidean space of classical mechanics. This theory is re-expressed so as to take account of the relative motion evidenced by the red shift and also, if necessary, of the curvature of space. In the first section special relativity is employed, the motion of the galaxies is kinematic, and their gravitational interaction is ignored. It turns out that all the relevant quantities can be expressed in terms of elementary functions.

The extension to general relativity is explained in the second section. While gravitation can now be allowed for, the theory is mathematically far more complicated. A.

523.872

7651. On obtaining recordings of stellar spectra, and the determination of gradients by the use of a photoelectric spectrophotometer. P. GUÉRIN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 26, 2484–6 (*June* 27, 1955) In French.

Recently, some thirty direct recordings of spectra of bright, early-type stars have been made with a new photoelectric spectrophotometer at the Cassegrain focus of the 81 cm reflector of the Haute-Provence observatory, using a slit-width of 0·1 mm. The spectral range covered is from 3 500 to 6 000 Å. The magnitude-limit, depending on the signal-noise ratio of the electronic equipment, is $6^m{\cdot}0$ at a working temperature of 8°C; and $8^m{\cdot}5$ at 0°C, i.e. about equal to that of the small photographic spectrograph used with the same telescope. Parasitic fluctuations impose a flux variation of $\sim \pm 30\%$ of the mean value; and this should be capable of reduction in subsequent designs. The recorded spectra are free from distortion; and serve as a satisfactory datum for the evaluation of spectrophotometric gradients, and Balmer discontinuities. The results for 5 early-type stars are found to agree well with those previously derived by Chalonge using a photographic method.

D. R. BARBER

523.872

7652. The spectra of binary stars. O. STRUVE. *Stellar Atmospheres Conference* [*Indiana*] 33–7. See Abstr. 7656 (1955).

This paper is concerned with three stellar groups: (i) the β Canis Majoris class; (ii) the visual binaries on and near the main sequence; and (iii) the supergiant double, ϵ Aurigae. One notable star, of group (i), viz. BW Vulpeculae shows a discontinuous radial-velocity curve indicating the probable ejection of discrete gas clouds every 4 hours and 50 minutes, the clouds being decelerated by gravity to fall back into the star. No inward contraction is indicated as in a normal pulsating star. Sharp lines of CH^+ have been found recently in the spectrum of ϵ Aurigae which may be either inter- or circumstellar. In addition, a strong, sharp component of Ca II has been observed with a velocity of -28 km/sec at all phases. This large and constant negative velocity, which departs radically from the expected interstellar values, probably represents a circumstellar component originating in an expanding gas-cloud which envelopes the entire binary system. D. R. BARBER

523.872

7653. Some observational results on the spectra of late-type giant stars. A. MCKELLAR. *Stellar Atmospheres Conference* [*Indiana*] 163–76. See Abstr. 7656 (1955).

The first two sections are based on spectrographic observations of the cool C stars. Recent i.r. spectrograms of late N-type stars in the 9 600–11 000 Å region not previously photographed show the most outstanding stellar absorption features to be the four heads of the 0,0 band of the red system of CN at 10 872, 10 926, 10 964 and 11 009 Å. Since this band has the same origin in the ground electronic state of CN as the violet system at 3 883 Å, the transition probability in the two bands must be equal. Thus, if the C stars have the same opacity in u.v. and i.r. the two bands should appear about equally intense. However, for these late N-type stars, it is found that although the 0,0 i.r. band-system is strong; that in the u.v. is either extremely weak, or absent. It is concluded that the opacity at 3 883 Å is very much higher than at 10 900 Å. Early N-type stars show neither this drastic drop in intensity in the near u.v., nor the 4 053 Å C_3 bands with which the drop is correlated in late N-type spectra. It appears probable therefore that polyatomic molecules, e.g. C_3, are responsible for the u.v. veiling. D. R. BARBER

523.872 : 523.77

7654. Revised curves of growth for alpha Persei, and epsilon Aurigae; and a discussion of the solar curve of growth. K. O. WRIGHT. *Stellar Atmospheres Conference* [*Indiana*] 128–36. See Abstr. 7656 (1955).

New curves of growth for Fe I lines in the two stars, α Persei and ϵ Aurigae, based on the author's observed equivalent widths (1948), and the laboratory data of Crosswhite (1950), are compared with solar growth-curves computed in a similar manner. A comparison is also made between turbulent velocities for high- and low-excitation lines of Fe I computed on the basis of (*a*) laboratory intensity data; and (*b*) solar "*f*" values. A systematic difference in the velocities derived from high- and low-excitation lines is suggestive of a stratified atmosphere in the supergiant stars. The solar Fe I lines cannot be considered to follow a single curve of growth indicative of a definite temperature. Such a curve cannot therefore yield valid "*f*" values. D. R. BARBER

523.872 : 535.331

7655. The empirical determination of line strengths from stellar emission lines. L. H. ALLER. *Stellar Atmospheres Conference* [*Indiana*] 80–6. See Abstr. 7656 (1955).

A description is given of an attempt to derive empirical "*f*" values—via the curve of growth—from the rich emission spectrum of XX Ophiuchi. Empirical curves of growth are obtained for Ti II, Fe II and He I lines in this star, using assumed temperatures of 4 300 and 12 000°K respectively. A plot of $\log gf$ for the star against the same parameter derived from solar data shows pronounced scatter. Part of this may arise from fluorescent effects in the extended shell of this star. The study has shown that reliable relative line strengths cannot be obtained from such data.

D. R. BARBER

523.877

7656. Stellar atmospheres. Edited by M. H. KRUBEL. *Indiana, U.S.A.: The University* (1955) 183 *pp.*

Proceedings of a conference sponsored by the National Science Foundation and held at Indiana University—September 30, October 1–2, 1954. Thirty-four papers were presented under sectional headings: (A) Basic observational data, 7 papers; (B) Fundamental experimental data, 10 papers; (C) Model atmospheres and line profiles, 7 papers;

(D) Equivalent widths and the curve of growth, 5 papers; (E). The atmospheres of giants and supergiants, 5 papers. For abstracts of some of these, see Abstr. 7646–7, 7652–5, 7657–60, 7822, 7827–9 (1955).

523.877

7657. Energy distribution of stars. A. D. CODE. *Stellar Atmospheres Conference* [*Indiana*] 14–19. See Abstr. 7656 (1955).

An account is given of the procedure adopted to place the method of 6-colour photometry on an absolute basis. The standard source chosen was the sun, whose energy distribution is fairly well known; and comparison between the sun and the selected standard stars of near solar-type was made via a secondary tungsten ribbon-filament source. The comparison method was a null one. Absolute measures for ~30 stars obtained at Lick, and Mount Wilson observatories during 1954 provide a nucleus of fundamental observational data for use in theoretical astrophysics.

D. R. BARBER

523.877

7658. On the significance of the hydrogen–helium ratio determined from model atmospheres. A. B. UNDERHILL. *Stellar Atmospheres Conference* [*Indiana*] 101–3. See Abstr. 7656 (1955).

It is pointed out that, if coarse analysis, based on a single-layer approximation of the stellar atmosphere at one temperature and pressure, is used to estimate the H–He abundance ratio, the results will be uncertain within a factor of ~5. More rigid model atmosphere computations yield results uncertain by a factor of ~0·5. D. R. BARBER

523.877

7659. The atmosphere of an RV Tauri variable. H. A. ABT. *Stellar Atmospheres Conference* [*Indiana*], 158–61. See Abstr. 7656 (1955).

The paper describes the application of the empirical curve of growth method to line intensities of Fe I and Fe II in the spectrum of U Monocerotis. Seventeen spectrograms were available, covering 4 cycles. It was found that, at certain times when only single lines were present, the apparent abundance derived from the curves of growth changes by a factor of between 10 and 100. A plausible explanation is a variable continuous opacity within the regions of line formation. Plots of ionization temperature, and electron pressure with phase show a marked similarity, cycle for cycle, indicating a constancy with rates of change of temperature and log. electron pressure for all cycles. D. R. BARBER

523.877

7660. Recent work on Cepheid atmospheres. C. WHITNEY. *Stellar Atmospheres Conference* [*Indiana*] 177–81. See Abstr. 7656 (1955).

The log. decrements associated with acoustic waves in an infinite, homogeneous medium have been computed from graphical integrations of the exact dynamic equations applicable to a piston oscillating in an infinite, isothermal atmosphere in a gravitational field. Log. decrement values for three temperatures, 5 000, 10 000 and 20 000°K are tabulated for a range of densities considered typical of those existing in the atmospheres of supergiant stars. D. R. BARBER

523.877

7661. Stellar pulsation as a limit-cycle phenomenon. W. S. KROGDAHL. *Astrophys. J.*, **122**, *No.* 1, 43–51 (*July*, 1955).

It is shown how the equations of motion for a pulsating star may be modified so as to make the system one possessing self-excitation. Limit-cycle solutions have been calculated for several illustrative cases. Indications as to how the corresponding velocity-curves relate to the observed curves for cepheids are given. A.

523.877

7662. Identification of the λ3143 interstellar line. A. MCKELLAR AND E. H. RICHARDSON. Note in *Astrophys. J.*, **122**, *No.* 1, 196 (*July*, 1955).

A weak, sharp interstellar line at 3 143·2 Å, reported by Spitzer and Field (1955) as being present in the spectrum of ζ Persei, is identified as the $Q_2(1) + {}^QR_{12}(1)$ line of the $^2\Sigma^+$, $^2\Pi$ transition of CH.

D. R. BARBER

529.78

7663. The physics of clocks and watches. J. F. W. BISHOP. *J. sci. Instrum.*, **32**, *No.* 8, 289–93 (*Aug.*, 1955).

The mode of operation of the component mechanisms of clocks and watches is reviewed, and the errors in timekeeping which they introduce discussed together with the steps which are taken to rectify them. A review of mechanical clocks includes a consideration of the pendulum and circular, temperature, barometric and escapement errors. Specific escapements are discussed. Spring, temperature and escapement errors in watches are considered and the methods of compensating for them discussed. A brief account of the marine chronometer and the Shortt clock is followed by a section on the quartz oscillator. A.

PHYSICS 53

53.081

7664. Fundamental quantities in electromagnetism. P. DE BELATINI. *Istanbul Tek. Üniv. Bült.*, **6**, 11–28 (1953) In German.

A detailed application is made of the "improved morphology" developed in a previous paper [Abstr. 7099 (1954)]. Electric charge is regarded as an unsatisfactory fundamental concept and, in place of the duality, magnetism-electricity, the triplicity, magnetism-"dielectricity"-electricity, is introduced. It is claimed that in the new system the electromagnetic laws may be expressed with the greatest amount of symmetry. R. A. NEWING

FUNDAMENTALS 530.1

530.1

7665. On a group-theoretical systematization of elementary particles. J. RAYSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 5, 255–7 (1955).

Particles are arranged into families according to the postulate that to every irreducible representation

(single- or double-valued) of the group of rotations and reflections in space, there should correspond two particle types. A table is drawn up giving two tensor and two pseudotensor families of bosons and six families of fermions. Particles of higher spin can be described by a bilocal formalism in which the mass spectrum formulae give zero mechanical mass for the neutrino, electron, muon and pion. G. FIELD

530.12

7666. Contribution to the final affine field law. J. I. HORVÁTH. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 3, 151–5 (1955).

The condition for parallism in affine space is discussed and it is shown that in general it is not possible to introduce transformations S of affine connection, which preserve parallism, in such a way that the new connection is symmetric. New coefficients may, however, be introduced such that $\Gamma^i_{ji} = \Gamma^i_{ij}$. It is suggested that, in constructing affine theories, the field equations and the equations of motion in their parameter invariant form should be invariant under transformation of type S. R. A. NEWING

530.12

7667. The equations of motion in the general theory of relativity and the coordinate condition. H. J. MEISTER AND A. PAPAPETROU. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 3, 163–8 (1955) In German.

It is shown that no co-ordinate condition is necessary in the 1st approx.; the Newtonian equations follow on the assumptions that the gravitational field is weak and quasi-static and that the 1st approx. to the energy-momentum tensor has the same form as in special relativity. R. A. NEWING

530.12

7668. New field equations in Jordan's theory of gravitation. K. JUST. *Z. Phys.*, **140**, *No.* 5, 485–93 (1955) In German.

Field equations are derived from a variation principle with a Lagrange function of the general form $U(J)\{R + V(J) + W(J)J_{|\nu}J^{|\nu}\}$ [see also Abstr. 2389 (1955)], and various special cases arising from particular choices of the functions U, V and W are discussed. R. A. NEWING

530.12

7669. On planetary motion in the case of a variable "constant" of gravitation. K. JUST. *Z. Phys.*, **140**, *No.* 5, 524–30 (1955) In German.

The author's 5-dimensional variation principle [Abstr. 2389 (1955)] is expressed in a 4-dimensional form with Lagrange function $\kappa^c(R + s\sigma^{|\nu}\sigma_{|\nu})\sqrt{(-g)}$, where κ is the constant of gravitation, here treated as a field variable, $\sigma = 1n\kappa$ and s and c are constants. A Schwarzschild-type solution of the field equations is derived and exact, or approximate, agreement with general relativity is obtained in the cases $c = 0$, $|s| \sim 1$ and $c = 1$, $|s| \gg 1$ respectively. R. A. NEWING

530.12

7670. On the field equations of unified relativistic theory. F. DE SIMONI. *R.C. Accad. Naz. Lincei*, **18**, *No.* 3, 297–304 (*March*, 1955) In Italian.

Field equations are derived from a variational principle and the consequences of various assumptions concerning the variation of $\mathfrak{g}^{ik}$ are investigated. Modifications of Einstein's unified field equations proposed by various authors are included as special cases in Simoni's general scheme. R. A. NEWING

530.12

7671. On the importance of the "fundamental group" in the problem of the unification of physical fields. G. ARCIDIACONO. *R.C. Accad. Naz. Lincei*, **18**, *No.* 4, 386–91 (*April*, 1955) In Italian.

The Maxwell equations are invariant under the transformations of the restricted Lorentz group Lz^6_{3+1} which has the same structure as the six-parameter orthogonal group O^6_4 of rotations in 4-space. Fantappiè has proposed [Abstr. 5210 (1955)] the group Fn^{10}_{3+1} (isomorphic with O^{10}_{4+1}) as the final group of physics, and hence the electromagnetic equations must be modified to ensure invariance under this group. In this preliminary paper it is noted that the replacement of the group O^3_3 (rotations in 3-space), associated with static fields, by the group O^6_{3+1} makes possible the unification of electric and magnetic fields. The transition to O^{10}_{4+1} is expected to involve a further unification of fields. R. A. NEWING

530.12

7672. Interpretation of Y. Thiry's theory in a conformal metric. F. HENNEQUIN. *C.R. Acad. Sci. [Paris]* **240**, *No.* 25, 2378–80 (*June* 20, 1955) In French.

In the 5-dimensional theory, space-time has been taken to be defined by the metric tensor $g_{ij} = \gamma_{ij} - \gamma_{i0}\gamma_{j0}/\gamma_{00}$. An approximation procedure developed by the author is used to show that a conformal space-time can be found in which the theory agrees with general relativity in the special case of an uncharged particle. R. A. NEWING

530.12

7673. Unified six-dimensional theory. Interpretation in the case of the meson-electromagnetic field. J. RENAUDIE. *C.R. Acad. Sci. [Paris]* **240**, *No.* 25, 2380–2 (*June* 20, 1955) In French.

530.12

7674. On the perihelion motion according to Littlewood's equations. F. A. E. PIRANI. *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 535–7 (*July*, 1955).

It is shown that the static spherically symmetric solution of the equations of Littlewood's conformal theory [Abstr. 4585 (1953)] leads to a perihelion motion of 1/6 the observed amount in the wrong direction. R. A. NEWING

530.12 : 523.112

7675. On the cosmological implication of galactic magnetic fields. II. R. L. BRAHMACHARY. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 149–51 (*July*, 1955).

See Abstr. 6725 (1955). Interior and exterior solutions are obtained and are discussed briefly. R. A. NEWING

530.12 : 530.145

7676. Quantum field theory and the two-body problem of general relativity. E. CORINALDESI. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1289–90 (*June*, 1955).

It is reported that the Einstein–Infeld–Hoffmann equations may be derived from quantum field theory by using S. N. Gupta's representation of relativistic theory in terms of flat space with a suitable Lagrange density. R. A. NEWING

530.12 : 530.145

7677. Lagrangians linear in the "velocities." E. Newman and P. G. Bergmann. *Phys. Rev.*, **99**, *No.* 2, 587–92 (*July* 15, 1955).

Lagrangian linear in the first-time derivatives are of sufficient importance in physics (particle fields, general relativity in the Palatini formulation, Einstein–Strauss type unified field theory, etc.) to warrant special consideration. The treatment is patterned after Dirac's more general exploration of Lagrangians leading to algebraic relations between the canonical variables. In the present case, the number of such constraints is at least as large as the number of configuration co-ordinates. The secondary constraints are free of canonical momentum densities. All the possibilities that may arise have been examined—incompatibility of the field equations, proper Cauchy–Kowalewski problems and the appearance of arbitrary functions in the solutions. Appropriate quantization procedures for the compatible cases are indicated. A.

530.145

7678. Equations of motion for linear field-theories. L. Infeld. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 4, 213–16 (1955).

The derivation, as opposed to the formulation, of the equations of motion from the field equations is shown to be possible by adding the gravitational equations to those of the linear field. G. FIELD

530.145

7679. Semi-classical treatment of general forces in the Feynman representation. P. Choquard. *Helv. phys. Acta*, **28**, *No.* 2–3, 89–157 (1955) In French.

The restriction in Feynman's space-time approach to potentials not involving x to higher powers than the second is removed and Pauli's semi-classical method is used to deal with quite general, in particular strongly anharmonic, potentials. The behaviour of the corresponding action integrals is studied and a method of calculating them is developed. The construction of non-relativistic Feynman kernels is generalized for the cases of arbitrary systems, conservative or non-conservative, with particles possessing spin, and of systems described in curvilinear co-ordinates. Two methods are developed for extending the treatment to the relativistic case. They are shown to be good approximations to the exact solutions for certain regions of their arguments. G. FIELD

530.145

7680. Functional integrals and adiabatic limits in field theory. S. Deser. *Phys. Rev.*, **99**, *No.* 1, 325–7 (*July* 1, 1955).

The behaviour of a system of coupled fields as some of the particles become very heavy is investigated. By means of a technique expressing the relevant exact Green's functions as functional integrals, the limiting process need only be performed for bare one-particle propagators to get the result for the exact functions. It is shown that the resultant propagators are those for the remaining finite masses moving in external fields generated by the heavy particles acting as static point sources. The situation in which the coupling to the intermediate fields has no simple non-relativistic limit is also discussed. A.

530.145

7681. Many-point correlation-functions in quantum field-theory. E. Freese. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 50–7 (*July*, 1955).

The many-particle propagators (τ-functions) may be generated as functional derivatives, with respect to external sources, of the vacuum expectation value of the S-matrix. Related functions may be obtained similarly from the corresponding logarithm. It is pointed out that the latter have the property of being small unless the proper distances between the co-ordinates are all small. This might form the basis of a new type of approximation. P. T. MATTHEWS

530.145

7682. Propagators of quantized field. P. T. Matthews and A. Salam. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 120–34 (*July*, 1955).

Feynman's formulation of quantum mechanics—the sum over histories—is discussed in its field theoretic form. It expresses the propagators of the interacting fields as functional integrals over the fields. The integrals over the anti-commuting Fermi fields are carried out. The complete propagators, including all radiative corrections, are thus expressed as functional integrals, over the meson field, of integrands involving the single nucleon propagator and the vacuum to vacuum transition amplitude in an external field. The latter factor is the Fredholm determinant of the external field problem for "nucleons" satisfying Fermi statistics, but its inverse if Bose statistics are assumed. These expressions for the propagators display some interesting distinctions between "renormalizable" and "unrenormalizable" interactions which are quite independent of an expansion in the coupling constant. A.

530.145

7683. Perturbative expansions. E. R. Caianiello. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 155–9 (*July*, 1955).

Continuing previous work [Abstr. 6270 (1954)], expressions are obtained for scattering kernels from which vacuum terms have been removed, and power series expansions of these kernels with compact, though formal, expressions for the remainders. P. T. MATTHEWS

530.145

7684. On reduction formulae in field theory. S. S. Schweber. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 173–5 (*July*, 1955).

The reduction formulae of Lehmann, Symanzik and Zimmermann [Abstr. 1510 (1955)] are rederived. P. T. MATTHEWS

530.145

7685. Non-perturbative expansions. E. R. Caianiello. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 186–8 (*July*, 1955).

Alternative expansions of the scattering kernels are developed and their relation to the existence problem of solutions to field theory is discussed. P. T. MATTHEWS

530.145

7686. On linear electrodynamics with higher derivatives. Z. Szymański. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 4, 217–22 (1955).

An extension of Podolski's generalization of electrodynamics. The introduction of derivatives higher than the second, of finite order n, of the four-vector

potential A_α is shown to lead to an equation of the type $\prod_{j=1}^{n-1}(\Box - \mu_j^2)A_\alpha = 0$. G. FIELD

530.145

7687. Theory of radiation. J. C. GUNN. *Rep. Progr. Phys.*, **18**, 127–83 (1955).

Recent developments in the theory of radiation have brought this subject to a very complete state. There is a nearly closed domain, in which the interaction between charged particles and the electromagnetic field can be considered as isolated from other phenomena such as mesonic interactions. Within this domain it is now possible to calculate any process with a precision only limited by the labour of the actual calculations. This progress requires for its achievement that quantum field theory should be developed in a relativistically covariant form. The early sections of this review are devoted to a systematic description of the methods of quantization as applied to various matter fields—the scalar meson field considered first for its simplicity, the electromagnetic field and the electron–positron field. Coupled field equations are then discussed, and their solution in the interaction representation is described. The Feynman–Dyson procedure is established for the evaluation of *S*-matrix elements and applied to typical cases. A general description is given of different methods of renormalization of the *S*-matrix, and it is shown how this is equivalent to an elimination of unobservable parameters, and a description of phenomena in terms of the (formally infinite) electron mass and charge. A series of individual problems, exhibiting radiative corrections, including the Lamb shift and the anomalous magnetic moment of the electron are considered in more or less detail. Some brief concluding remarks are appended on the development of approximations likely to be useful in meson theory. Over 60 refs. A.

530.145

7688. Quantummechanical forces acting on photons. K. NAGY. *Acta phys. Hungar.*, **4**, *No.* 4, 327–31 (1955).

By the aid of the scalar representation of the electromagnetic field a statistical ensemble is constructed which describes the statistical behaviour of photons. Following D. Bohm's interpretation of quantum mechanics it is shown that here also the motion of a single photon is affected by quantum-mechanical forces. Finally some difficulties of this interpretation are mentioned. A.

530.145

7689. On the emission of photons in the approximation of Bloch and Nordsieck. R. ASCOLI. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 1–10 (*July*, 1955) In Italian.

Investigates the characteristic properties of the emission of an infinite number of photons which occurs, in the Bloch and Nordsieck treatment, in all the processes in which a charged particle undergoes a transition from a definite momentum state to another definite momentum state. For electronic charges the probability of one of the photons falling in the frequency range that interests in ordinary experiments is found to be no more than some hundredths, in agreement with the perturbation method. This probability, however, may approach unity at very high energies in nuclear events of cosmic rays. The results, moreover, depend strongly upon the value of the charge and the probability of nuclear charges emitting several photons is considerably increased. In the case of macroscopical charges multiple emission usually occurs. A.

530.145

7690. Representation of the Green's function in quantum electrodynamics in the form of functional integrals. I. M. KHALATNIKOV. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 5, 633–6 (1955) In Russian.

A formal expression for the one-electron Green's function is given, but no attempt is made to solve it. G. E. BROWN

530.145 : 538.3

7691. On the angular momentum of the electromagnetic field. N. CARRARA, T. FAZZINI, L. RONCHI AND G. TORALDO DI FRANCIA. *Alta Frequenza*, **24**, *No.* 2, 100–9 (*April*, 1955) In Italian.

The density of angular momentum of an e.m. field may be calculated from momentum considerations or more generally from field theory. The two expressions are compared by showing how they can be both deduced from a principle of least action. They are equivalent in all cases of practical interest, as far as the total angular momentum carried by a wave is concerned, but in the classical theory angular momentum is mainly localized at the boundary of the wave while, according to field theory, its distribution, arbitrary to a certain degree, is more uniform. L. PINCHERLE

530.145

7692. A contribution to the theory of the Pauli–Fierz equation for a particle with spin 3/2. M. PETRÁŠ. *Czech. J. Phys.*, **5**, *No.* 2, 160–70 (*April*, 1955).

Commutation rules for the Pauli–Fierz equation are given in the "parametric" form. The Hamiltonian and subsidiary conditions for a free particle are derived. The two subsidiary conditions are in a form which expresses that an operator and its time derivative applied to the wave-function give zero. The practical applicability of the formalism of "parametric" commutation rules for special computations is verified by an example of the magnetic moment. A.

530.145

7693. Relativistically invariant equations for the electron, replacing the system of equations of Dirac. G. A. ZAĬTSEV. *Zh. éksper. teor. Fiz.*, **28**, *No.* 5, 530–40 (1955) In Russian.

The non-relativistic theory of a particle of spin $\frac{1}{2}$ developed earlier [Abstr. 2410 (1955)] is generalized, to a relativistically invariant theory. In this fashion a differential equation of second order connecting components of a single real spinor is obtained. This equation is solved for the hydrogen atom and is found to reproduce the correct fine structure. G. E. BROWN

530.145

7694. Several remarks on possible formulations of the theory of extended particles. V. S. BARASHENKOV. *Zh. éksper. teor. Fiz.*, **28**, *No.* 5, 579–83 (1955) In Russian.

Remarks on the violation of relativistic invariance in non-local field theories are made. It is shown that

theories of a Yukawa type where field operators are non-diagonal in the x-representation cannot be equivalent to a number of local fields. G. E. BROWN

530.145

7695. Stationary states of a particle system in interaction with a field. M. FABRE DE LA RIPELLE. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 26, 2488–90 (*June* 27, 1955) In French.

In this continuation of previous work [Abstr. 8066 (1954)] a method is given for obtaining an equation describing semi-stationary states. G. FIELD

530.145

7696. Non-linear integral equation in field theory. S. FUBINI. Letter in *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 1, 180–2 (*July*, 1955).

A set of non-linear integral equations between scattering amplitudes is derived. The first approximation coincides with the results of Low [Abstr. 3453 (1955)]. P. T. MATTHEWS

530.145

7697. Current density in Heisenberg representation. M. CINI AND S. FUBINI. Letter in *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 1, 192–4 (*July*, 1955).

A non-linear equation is derived for the current density operator, which may be expressed as an infinite set of coupled non-linear equations for scattering amplitudes. P. T. MATTHEWS

530.145

7698. The elastic scattering of charged particles by nuclei. A. J. FERGUSON. *Atomic Energy Canada Rep. No.* 157, 47 *pp.* (*Aug.*, 1954).

The angular distribution formula of Blatt and Biedenharn [Abstr. 1100 (1953)] is generalized so that the nuclear part of the scattering is represented by a general phase-shift expression. Cases in which this representation of the scattering matrix can be simplified are discussed. The angular distribution is represented by Legendre polynomials in conjunction with functions arising from interaction of nuclear and Coulomb waves. Tables of these functions are included. N. M. KING

530.145

7699. Covariant treatment of the nucleon–nucleon interaction. H. S. GREEN. *Proc. Phys. Soc. A*, **68,** *Pt* 7, 577–84 (*July*, 1955).

An approximate covariant solution of the Salpeter–Bethe equation is obtained by a modification of the Fredholm theory. This solution is developed to the point where only numerical substitutions are required to obtain the scattering amplitudes and differential cross-sections for elastic nucleon–nucleon collisions, for any energy and any spins of the incident and scattered particles. A.

530.145

7700. Interaction of nonlocal and local fields. W. D. SCHULZ. *Phys. Rev.*, **99,** *No.* 1, 290–301 (*July* 1, 1955).

A system of a scalar non-local (meson) field and a spinor local field is considered. Through the introduction of an invariant projection operator the interaction term is chosen with close consideration to the angular momentum properties of the non-local field. When the interaction is so chosen that the system is restricted to spin zero mesons, the system is shown to be equivalent to a system of local fields in non-local interaction. The convergence properties introduced by the non-local field are always due to form invariant functions even when higher spin mesons are allowed in the theory. The close relationship of this theory to that of local fields in non-local interaction means that all the quantization difficulties of the latter are present here also. A.

530.145

7701. Remarks on pion–nucleon scattering. U. HABER-SCHAIM AND W. THIRRING. *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 1, 100–19 (*July*, 1955).

The scattering of pions on nucleons is considered under the assumption of pv-coupling with cutoff. A model due to Lee [Abstr. 9936 (1954)] is extended in two directions: (*a*) to include recoil effects and (*b*) to admit two mesons in the meson cloud of the nucleon. The model permits a rigorous renormalization prescription without the use of perturbation theory. The phase shifts for the $\frac{1}{2}\,\frac{1}{2}$ and $\frac{3}{2}\,\frac{3}{2}$ scattering can be calculated to any desired accuracy, in this paper about 10%. A.

530.145

7702. Renormalization in the new Tamm–Dancoff theory of meson–nucleon scattering. R. H. DALITZ AND F. J. DYSON. *Phys. Rev.*, **99,** *No.* 1, 301–14 (*July* 1, 1955).

The new Tamm–Dancoff equations for meson–nucleon scattering are set up in the lowest approximation and it is shown how explicit non-physical singularities may be avoided in these equations. The particle self-energies appearing in the integral equation are renormalized, but the resulting modified propagator for the system then has a non-physical singularity. For the states $T = j = \frac{1}{2}$, the vertex and self-energy expressions generated by the uncrossed graph are considered. The renormalized vertex may be constructed by the successive solution of two one-dimensional integral equations, the finite part of the self-energy then being obtained by quadratures. Vertex renormalization is uncertain to a constant factor in the $S_{\frac{1}{2}}$ state, and the $S_{\frac{1}{2}}$ theory therefore depends on two parameters. No numerical results are obtained, owing to a number of difficulties found in this theory—a comparison is made between these difficulties and those of the corresponding Bethe–Salpeter equation. A.

530.145

7703. Decay of spin-zero mesons into two leptons. H. MIYAZAWA AND R. OEHME. *Phys. Rev.*, **99,** *No.* 1, 315–16 (*July* 1, 1955).

The following general theorem is formulated: The matrix element for the decay of spin-zero mesons with mass m into two leptons with masses μ_1 and μ_2 respectively, contains only terms proportional to μ_1/m and μ_2/m, if in the open polygonal arc of lepton lines the number of matrices γ_μ plus the number of internal lines (S_F-functions) is odd. There can also be terms proportional to μ_i/m if virtual leptons with $\mu_i \neq \mu_1, \mu_2$ appear in the arc. Application of this theorem to the reaction $\pi^0 \to e^+ + e^-$ leads to a ratio of the one pair to the two pair decay of the order $(\mu_e/m_{\pi^0})^2 \sim 10^{-5}$. *A priori* one would expect

this ratio to be of the order one. Furthermore, the theorem provides a more general basis for the discussion of the relative probability of the reactions $\pi \to \mu + \nu$ and $\pi \to e + \nu$. A.

530.145

7704. Calculation of the matrix elements of the retardation factor with hydrogen eigenfunctions. G. ELWERT. *Z. Naturforsch.*, **10a**, *No.* 5, 361–5 (1955) In German.

The quantity $\varepsilon^n_{n_0}(q) = \int e^{iqx}\psi_{n_0}\psi^*_n dx$, where n_0 and n stand for a set of quantum numbers, is calculated. The eigenfunctions are expressed in parabolic co-ordinates. G. E. BROWN

530.145

7705. On the quantum theory of non-linear wave equations. III. W. HEISENBERG, F. KORTEL AND H. MITTER. *Z. Naturforsch.*, **10a**, *No.* 6, 425–46 (1955) In German.

The theory of elementary particles, based on a spinor field coupled non-linearly to itself, is continued [Abstr. 8030 (1954)]. The potential between two spinor particles and the mass spectrum of the Bose particles are calculated. The theory is shown to imply the existence of a Bose particle of zero mass. P. T. MATTHEWS

530.145

7706. Quantum-mechanical perturbations giving rise to a statistical transport equation. L. VAN HOVE. *Physica*, **21**, *No.* 6, 517–40 (*June*, 1955).

The quantum-mechanical theory of the transport equation is reconsidered for the case of transport processes produced by a small perturbation. On the basis of the most common applications of the equation to crystals (heat conduction, etc.) a characteristic property of the perturbation is recognized as being responsible for the appearance of dissipative effects in the time evolution of the system. With the help of this property a greatly improved derivation of the transport equation is obtained. It avoids the repeated use of a random phase assumption after each of a long succession of short time intervals, a common drawback of the conventional derivations. The validity of the transport equation is established without *a priori* statistical hypothesis for two special classes of initial states. It is also derived for arbitrary initial states with the help of a random phase assumption concerning the initial state alone. A.

530.145

7707. On the determination of wave-functions with localized moving singularities, describing circular trajectories for the case of an external, central potential. G. PETIAU. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 26, 2491–2 (*June* 27, 1955) In French.

Solutions of the time-dependent Schrödinger equation are found which have localized singularities moving in circular orbits corresponding to those of a classical particle in an external central field of force. G. FIELD

530.145

7708. The Bethe–Salpeter equation for many-body systems. R. O. A. ROBINSON. *Canad. J. Phys.*, **33**, *No.* 7, 369–82 (*July*, 1955).

The mathematical technicalities involved in reducing the Bethe–Salpeter equation to the Schrödinger form of a wave equation are simplified by means of a formal modification of the interaction process for systems of many particles. This also makes it possible to carry out the reduction in a unique manner. The consequences of the modification are clearly explained, and it is shown that for atomic systems numerical results remain unchanged to order α^2. There would seem to be some grounds for believing that numerical results remain unchanged to all orders, but no formal proof of this has been achieved. A.

530.152.15

7709. The domain model of hysteresis. I. Independent domains. J. A. ENDERBY. *Trans Faraday Soc.*, **51**, *Pt* 6, 835–48 (*June*, 1955).

A new theoretical treatment of the independent domain model of hysteresis is described in which measurable quantities are derived directly. It is shown that Everett's theorems [Abstr. 10816–17 (1954)] for his variable ξ, representing the fraction of the system in a given state, do not all apply to a more general variable, and amended versions of these theorems are obtained which are generally applicable. Relations between the various scanning curves are derived which would permit an experimental test of the theory. The theory is extended to deal with more than one independent variable, and the possible verification of some thermodynamic relations is discussed in terms of this extended theory. A.

530.162

7710. Further remarks on the odd ball problem as an example in information theory. H. MITCHELL AND R. N. WHITEHURST. Letter in *J. appl. Phys.*, **26**, *No.* 6, 778–9 (*June*, 1955).

Shows that if the number of balls is given by the integer $(3^n - 1)/2$, the problem is not solvable unless a single good ball is also available, a result which is also known from mathematical induction. T. J. REY

530.162

7711. Proof of the Heisenberg relations. D. TER HAAR AND W. M. NICOL. Letter in *Nature* [*London*] **175**, 1046 (*June* 11, 1955).

The proof of the uncertainty relation follows from the inequality $|\alpha x\psi + (\partial\psi/\partial x)|^2 \geqslant 0$ if the constant α is given the value $(2\Delta x^2)^{-1}$. It is pointed out that this value of α results from the Gaussian form of ψ in the optimum case with the equality sign. W. A. HEPNER

530.162

7712. A new derivation of the fundamental formulae in Fowlerian statistical mechanics. J. S. R. CHISHOLM AND A. H. DE BORDE. Note in *Proc. Cambridge Phil. Soc.*, **51**, *Pt* 3, 526–8 (*July*, 1955).

Representation of statistical averages by contour integrals is obtained without the use of generating functions. The restrictions which are due to the conservation of energy or the constancy of the number of particles are taken into account by means of a "δ-function," defined as $\delta(0) = 1$, $\delta(x) = 0$ for $x \neq 0$ and admitting representation by contour integrals. Formulation of the averages, due care being taken of the restrictions, leads almost automatically to Fowler's expressions. R. EISENSCHITZ

530.162 : 536.7

7713. Statistical thermodynamics of mixture of Bose–Einstein and Fermi–Dirac "liquids." S. M. Bhagat and P. K. Katti. *Proc. Nat. Inst. Sci. India*, **21**, *No.* 1, 21–43 (*Jan.*, 1955).

Smoothed potential models of the type used by Heer and Daunt are considered when the distribution laws have the generalized form introduced by Kothari and Singh. In the mixture the liquids are assumed to form statistically independent systems. The thermodynamic properties of mixtures (both above and below their λ-points) are derived when the "Fermi liquid" is (i) Boltzmannian, (ii) non-degenerate, and (iii) degenerate. Comparison with observed properties of He^3–He^4 mixtures is carried out. The behaviour of the specific heat, below 1°K, is found to be very sensitive to the nature of the Fermi liquid. A.

530.162 : 536.7

7714. Statistical analog of the second law. J. S. Thomsen. *Phys. Rev.*, **98**, *No.* 6, 1625 (*June* 15, 1955).

In recent papers Landsberg and the author [Abstr. 102 (1954), 753 (1955)] have used two different propositions to represent the statistical analogue of the second law of thermodynamics. The difference is discussed and the author's viewpoint presented. There is also included a necessary addition to a proof given in the author's previous analysis. A.

530.162 : 539.11

7715. An approximation method for order–disorder problems. I. J. Hijmans and J. de Boer. *Physica*, **21**, *No.* 6, 471–84 (*June*, 1955).

A systematic approximation method for order–disorder problems is developed, which is based on a principle introduced by Kikuchi. Each approximation is characterized by the choice of a certain basic figure and by the distribution of figures of this type in the lattice over their different configurations. The free energy of the system is shown to be a linear combination of the free energies of m-figure assemblies, corresponding to the basic figure and a series of smaller subfigures. Each m-figures assembly consists of N independent figures of type m, distributed over their configurations in the same way as figures of this type in the lattice. Simple rules are given for obtaining the weights, which have to be given to the different m-figure assemblies, and for determining the series of m-figures smaller than the basic figure, which has to be used. The free energy, obtained in terms of the distribution numbers for the basic figure and some of its subfigures, should be minimized with respect to these macro variables. A.

530.162 : 539.11

7716. An approximation method for order–disorder problems. II. J. Hijmans and J. de Boer. *Physica*, **21**, *No.* 6, 485–98 (*June*, 1955).

The equilibrium state of an order–disorder system is calculated by minimizing the expression for the free energy, obtained in Pt I, with respect to the distribution numbers for the basic figure and the corresponding series of subfigures as macrovariables. As these distribution numbers are interrelated by a number of geometric consistency relations, a set of independent macrovariables is introduced to facilitate the minimizing procedure. The equilibrium relations imposed on the distribution numbers, which are obtained in this way, take on a particularly simple form, when an additional transformation of variables is applied. In terms of these new variables the consistency relations can easily be obtained from so-called sums over configurations, which can be written down immediately by inspection of the involved figures. The method results in a simple closed expression for the free energy, in terms of a number of quantities, which can be calculated from the equations corresponding to the equilibrium-, and consistency relations, which are also given in a closed form. The formalism is illustrated by an example in which a bond of two neighbouring sites is chosen as the basic figure, giving the result of the Bethe-, or quasi-chemical approximation. A.

530.162 : 539.11

7717. An approximation method for order–disorder problems. III. J. Hijmans and J. de Boer. *Physica*, **21**, *No.* 6, 499–516 (*June*, 1955).

The method for treating order–disorder phenomena developed in Pts I and II is applied to a triangular lattice with a triangle and a rhombus as the basic figure. A general discussion is given of the suitability of different figures to serve as a basic figure in this method, particularly in connection with the introduction of "open" and "closed" figures by Kikuchi. It is shown that the generalization of the method given by Guggenheim and McGlashan, and the methods given by Yang, Li and by Fosdick and James, involving larger figures than a single bond, can be considered as particular cases of the present method. A.

GENERAL MECHANICS. MECHANICS OF SOLIDS 531

531.224

7718. Kinematic and energy considerations for flexure without torsion. B. Fraeijs de Veubeke. *Mém. Acad. Roy. Belg. Cl. Sci.* (*Coll. in*-8°) **29**, *No.* 2, 48 *pp.* (1955) In French.

A comprehensive mathematical analysis of the combined flexure and torsion of a beam with a multiply-connected cross-section. Trefftz's definition of flexure without torsion is adopted, based on energy considerations. This is shown to be equivalent to the vanishing of a certain weighted mean torsion (involving an average over the real filaments of the beam and virtual filaments defined in the cavities). The situation considered can be appreciably different from one in which the ordinary average torsion over the (real) filaments of the beam vanishes.

J. G. OLDROYD

531.51

7719. Deduction of Newton's law of gravitation from the property of the Galilean group. I. L. Fantappiè. *R.C. Accad. Naz. Lincei*, **18**, *No.* 4, 361–7 (*April*, 1955) In Italian.

The static, velocity-independent interaction between two point masses is assumed to be invariant under the transformations of the ten-parameter group G^{10}_{3+1} of Newtonian space-time. This assumption, together

with certain requirements of continuity and superposition is shown to be sufficient to determine the law of interaction. R. A. NEWING

MECHANICAL MEASUREMENTS 531.7

531.717.7

7720. The measurement of radius of curvature of test glasses with a ring spherometer. S. MOHOROVIČIĆ. *Optik*, **12**, *No.* 6, 285–92 (1955) In German.

Previous authors have discussed the correct choice of radius from the two values obtained with a ring spherometer. The geometric basis for these formulae is given and more precise methods given for deducing a single value of the radius. A numerical example illustrating the methods is included. R. W. FISH

531.719.3 : 539.185

7721. Using neutrons for remote liquid-level gaging. S. BARNARTT AND K. H. SUN. *Nucleonics*, **13**, *No.* 5, 47–9 (*May*, 1955).

The level of a hydrogenous liquid can be determined to within ±2 mm, by means of a fast neutron source together with a thermal neutron counter moved vertically outside the tank. A discontinuity in counting rate occurs as the counter moves past the surface, due to reflected thermal neutrons from the liquid. L. R. SHEPHERD

531.724 : 541.183

7722. Methods and techniques for the determination of specific surface by gas adsorption. A. S. JOY. *Vacuum*, **3**, *No.* 3, 254–78 (*July*, 1953; publ. *June*, 1955).

A critical review is made of experimental procedures for the determination of specific surfaces and relative surface areas by the method of measuring the volume of gas adsorbed on the surface of the solid. Volumetric and gravimetric techniques are described and compared, and their suitability for routine and research purposes is indicated. The difficulties usually associated with the determination of gas adsorption isotherms are discussed, and a brief description is given of the methods used for calculating surface areas from the adsorption data. A.

531.768 : 534.154

7723. Some developments in vibration measurement. S. EDELMAN, E. JONES AND E. R. SMITH. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 728–35 (*July*, 1955).

Describes cemented barium titanate accelerometers of two simple types, an electromagnetic shaker with a symmetrically mounted shake table, a set of barium titanate shakers, and two optical methods of accelerometer calibration, one using a microscope with a stroboscope of wide frequency range and one using a Fizeau type interferometer. Calibration results from 50 to 11 000 c/s are given. A.

531.77

7724. Zero signals in the Sperry tuning fork Gyrotron. C. T. MORROW. *J. Acoust. Soc. Amer.*, **27**, *No.* 3, 581–6 (*May*, 1955).

The Gyrotron consists of a tuning fork vibrating at its fundamental frequency and mounted so as to have a damped torsional resonance about the axis of symmetry at the same frequency. Rotation about this axis produces a torsional vibration, of magnitude proportional to the rate of turn, and of phase reversing with direction of turn, which is detected by a pickup. The present paper provides a partial analysis of zero signals, as produced by mass unbalance in the tuning fork, unbalance in the tuning fork drive, and asymmetry in the supports. The zero signal is shown to be highly independent of gravity and acceleration. A.

531.781 : 531.57

7725. Weigh-bar apparatus for measuring forces resisting ballistic penetration. J. M. KRAFFT. *Rev. sci. Instrum.*, **26**, *No.* 6, 539–42 (*June*, 1955).

A Hopkinson bar wire strain gauge technique has been developed for the measurement of projectile penetration-force as a function of time. The elastic strain wave resulting from projectile impact and penetration of the bar end is measured with oscillographic equipment; this strain pattern is a direct and continuous measure of the penetration force. Comparison of impacts measured by the bar with those obtained by a previously developed precision optical chronograph have shown increased accuracy, and a simplification of test procedure and analysis with the new method. A.

531.781.2

7726. Measurement of membrane tension. T. J. SCHULTZ. Letter in *Rev. sci. Instrum.*, **26**, *No.* 6, 624–5 (*June*, 1955).

The physical constants involved in determinations of the resonant frequencies and stiffness of vibrating membranes can usually be measured by simple means except for the membrane tension. Elastic theory is usually assumed to apply and the tension calculated from measurements of the resonant frequencies. This letter describes an independent method of measuring the membrane tension for the circularly symmetrical edge-clamped case. The membrane tension *v.* central deflection for a sample of mylar showed that the tension was substantially independent of the displacement. H. J. H. STARKS

531.787.3

7727. Experience with piston–cylinder balance for pressure measurements. H. H. REAMER AND B. H. SAGE. *Rev. sci. Instrum.*, **26**, *No.* 6, 592–3 (*June*, 1955).

A piston-cylinder balance has been found to be a satisfactory means of measuring pressures. Laboratory experience over a fourteen-year period in the use of such an instrument suitable for measurements up to 10 000 pounds per square inch, is presented. It was found that over a period of ten years the calibration changed by less than four parts in 10 000. This small change in calibration during nearly continuous service of the apparatus is an indication of the suitability of piston-cylinder balances for routine measurements. A.

531.787.6

7728. A double-sided micromanometer. J. J. OPSTELTEN AND N. WARMOLTZ. *Appl. sci. Res. B*, **4**, *No.* 5, 329–36 (1955).

On each side of a thin diaphragm, separating two chambers, a condenser plate is mounted at a small distance. The two capacities thus formed are part of

a bridge circuit which is fed by a high-frequency oscillator. An amplifier with a narrow bandwidth, a rectifier and a micro-ammeter are used as a null-indicator. At one side of the diaphragm a pressure prevails, much lower than the pressure to be measured, at the other side the gas is admitted the pressure of which is to be measured. The displacement of the membrane by the gas pressure is compensated electrostatically by the aid of a calibrated potentiometer. The reading of this potentiometer is a linear measure for the pressure as a result of the differential way of compensating. The range is from 10^{-5}–1 mm of mercury pressure difference at any absolute value. The apparatus is made of chemically fairly resistant materials, and its indication is in principle independent of the nature of the gas, so that it can be used for almost every gas. A.

531.787.6

7729. New absolute manometer for vapor pressures in the micron range. F. M. Ernsberger and H. W. Pitman. *Rev. sci. Instrum.*, **26**, *No.* 6, 584–9 (*June*, 1955).

An absolute manometer is described which provides a means of measuring vapour pressures in the range 0·5 to 20 microns with a precision and accuracy of better than 1%. Construction and use of the manometer is described in detail and an analysis of the possible sources of error is given. The vapour pressure of mercury has been determined and is presented to give an example of the performance of the manometer. A.

531.787.9

7730. Measurement of the pressure distribution between rollers in contact. G. J. Parish. *Brit. J. appl. Phys.*, **6**, *No.* 7, 256–61 (*July*, 1955).

The measurement of pressure distribution in industrial rolling processes has hitherto been carried out only on roller systems of the fixed gap type. The apparatus described here extends the measurement to processes in which there is no fixed gap between the rollers, and also to appreciably lower loads than any previously studied. A radial pressure pin is mounted in one of the rollers and transmits the load on its outer end to a pressure-sensitive device situated within the roller. Provision has been made for the investigation by actual pressure-distribution measurement of the effect on recorded pressure of the height of the pressure pin relative to the roller surface and of depression of the pin under load. Pin depression has been found to cause erroneous pressure recording, and a method of correction has been developed. A.

MECHANICS OF FLUIDS 532

532.133 : 541.64

7731. The viscosity of linear and branched-chain polymers. A. Peterlin. *Z. Naturforsch.*, **10a**, *No.* 5, 412–19 (1955) In German.

The modified Flory equation can represent the whole course of the viscosity curve for straight and branched-chain polymers. The linear polymers have a curve of viscosity v. degree of polymerization with a steadily decreasing slope, whereas branched polymers show a steady rise, if the monomer and low molecular weight parts are neglected. P. CUCKA

532.5 : 778.37

High-speed photography in the study of moving fluids. *See Abstr.* 8434

532.51

7732. On the instability of superposed fluids in a gravitational field. D. Layzer. *Astrophys. J.*, **122**, *No.* 1, 1–12 (*July*, 1955).

An approximate analytic solution is obtained for the following problem: A perfect, incompressible fluid occupies the upper half of a vertical tube, being supported against gravity by a rigid diaphragm. The lower half of the tube is empty. At time t_0 the diaphragm is removed, and an infinitesimal disturbance of a simple kind is impressed on the free surface of the fluid. The problem is to describe the subsequent flow, on the assumption that the fluid at sufficiently great heights above the free surface is permanently at rest. The initial disturbance is so chosen that the fluid rises in the centre of the tube and runs down at the sides. The range of validity of the approximate solution obtained is discussed. It is shown that the vertex height ζ increases exponentially, in agreement with the linearized theory, until $\zeta \simeq 0{\cdot}2\ \lambda/2\beta_1$, where λ is the diameter of the tube and β_1 is the first zero of the Bessel function $J_1(r)$. When $\zeta \lesssim 1{\cdot}5\ \lambda/2\ \beta_1$, it increases at a nearly constant rate. The method of solution described is applied to an analogous problem involving two-dimensional flow between parallel plane walls and also to spatially periodic flows. A.

532.51 : 530.145

7733. On the quantum theoretical derivation of classical physics. I. Dynamics of gases and liquids. H. Kümmel. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1057–78 (*June*, 1955) In German.

Avoiding the direct limit $\hbar \to 0$, the passage from quantum to classical physics can be obtained by suitable assumptions about the states and eigenvalues of a system of particles, following Ludwig's conditions on macroscopic observables [Abstr. 1005 (1954)]. In the example of fluid dynamics it is shown that the passage to classical theory is effected by the introduction of the macroscopic observables of density, current density, and the stress tensor. W. A. HEPNER

532.51 : 530.162

7734. General statistical hydrodynamics in porous media. A. E. Scheidegger. *Geofis. pura appl.*, **30**, *No.* 1, 17–26 (1955).

The study of fluid flow in the ground is based upon the physics of flow through porous media. The author has recently proposed a theory [Abstr. 8949 (1954)] of such flow based upon the statistics of disordered phenomena which, however, was applicable to a special type of flow only. In the present paper, the earlier theory is developed into a general theory applicable to any type of microscopic flow equation. It is shown that the qualitative analogy which is observed between the equations of flow through porous media and the equations of flow through capillaries can be logically explained without the

assumption of capillaric models. Thus, a theorem is proved stating that the flow through porous media is described by the superposition of two effects: firstly, one corresponding to the average flow through a set of small channels, and secondly, a dispersivity effect. Finally, the results are applied to a variety of flow equations such as laminar flow, turbulent flow, and molecular streaming, all of which may occur in ground-water flow. A.

532.511 : 539.501

Theory of non-Newtonian flow. *See Abstr.* 8329–30

532.52 : 532.65

7735. Waterdrop collisions with solid surfaces. O. G. ENGEL. *J. Res. Nat. Bur. Stand.*, **54**, *No.* 5, 281–98 (*May*, 1955).

An approach is described to the difficult problem of the dynamics of an impinging water sphere. The flow in the impact plane is traced chemically. The stages in the collapse of the water mass and of its radial flow are shown in photographs that were taken with a high-speed motion-picture camera. Empirical determinations of the time dependence of the impact force and of the radial flow velocity are reported. The possible occurrence of cavitation in the radial flow is considered. A semiempirical analysis based upon various simplifying assumptions leads to equations for the maximum impact pressure and for the rate of spread of the water after the collision. A.

532.525

7736. Drop sizes from low speed jets. D. B. HARMON, JR. *J. Franklin Inst.*, **259**, *No.* 6, 519–22 (*June*, 1955).

Previous theoretical work predicting the drop size to be expected from a slow-speed jet is extended to the case in which the jet issues from a nozzle of sufficient length to assure fully developed laminar flow in the jet as it issues from the nozzle. It is shown that for a real liquid the jet contracts and the flow average velocity of the jet increases. Comparison of the theory with a single experimental result is made. A.

532.570.8 : 621.317.79

7737. Principles and application of the ultrasonic flowmeter. R. C. SWENGEL, W. B. HESS AND S. K. WALDORF. *Trans Amer. Inst. Elect. Engrs III*, **74**, 112–18 (1955) = *Pwr Apparatus Syst.*, *No.* 17 (*April*, 1955).

The velocity of an ultrasonic pulse is measured in both directions between transducers placed in the flowing liquid, and when t_d = time for wave to travel distance d downstream from one transducer to other, and t_u = time in upstream direction, the velocity = $\frac{1}{2}d(t_d^{-1} - t_u^{-1})$. The velocity is, therefore, independent of the velocity of ultrasound in the liquid. Any apparatus capable of measuring the propagation time between the transducers is satisfactory for making the velocity measurement. Details are given of the corrections to be applied when the path between the transducers is not parallel to the direction of flow of the liquid and also for determining the flow over a large area. The transducers employed consist of a magnetostrictive or piezoelectric generator coupled via a transition length with an aerial-like rod producing a conical radiation pattern. A. C. WHIFFIN (R)

CAPILLARITY 532.6

532.61.08

7738. Technique for measuring small differences in surface tension. N. O. YOUNG. *Rev. sci. Instrum.*, **26**, *No.* 6, 561–2 (*June*, 1955).

The method makes use of a horizontal capillary tube, which may, for example, have a temperature gradient along its axis. The velocity of a small sample within the capillary may then be measured, or brought to zero by tilting the tube. As a check, the temperature coefficient of surface tension of benzene and *n*-decane was measured to within 2% of previously published values. The method seems to be particularly adapted to the investigation of small samples. A.

532.65 : 541.18.04

7739. The effects of humidity deficit on coagulation processes and the coalescence of liquid drops. P. S. PROKHOROV. *Disc. Faraday Soc.*, *No.* 18, 41–51 (1954).

The mechanism of elementary processes of drop coalescence under static and dynamic conditions is considered. It is experimentally demonstrated that the coalescence of two drops, brought into contact, is prevented by the presence of an air-vapour gap between them. The saturation of the atmosphere surrounding the drops with the vapour of the same liquid is favourable for their coalescence. It is shown by theoretical treatment that the principal reason for the failure of drops to coalesce is a surplus pressure arising in the air-vapour gap between the drops due to suction of air into the gap from the exterior by the vapours of the liquid diffusing from the gap. Experiments under dynamic conditions were carried out in order to elucidate the effect of humidity deficit on the efficiency of drop collision. From the results obtained it follows that in considering the growth of water drops due to coagulation the dependence of the efficiency of drop collision on humidity deficit of the surrounding atmosphere should be taken into account. It has been found that the 100% efficiency of drop collision is realizable only under conditions of zero humidity deficit or in presence of supersaturation of the surrounding atmosphere with water vapours. A.

MOLECULAR THEORY OF LIQUIDS 532.7

532.7

7740. Transport processes in fluids. H. C. LONGUET-HIGGINS. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 140–53 (1955).

A review of existing theories of transport in fluids, written from a physical point of view and designed to help the experimenter make the best use of his data. The main topics discussed are the Enskog theory of dense gases and the theories of Kirkwood and of Eyring concerning liquids. It is suggested that the most fundamental experimental questions, at present open, are the relation between D and η and the dependence of transport coefficients on density.

R. O. DAVIES

532.7

7741. Transport phenomena in melts and the mechanism of melting. A. R. UBBELOHDE. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 126–39 (1955).

A review of recent data bearing on the structure of melts in anisotropic, non-polar materials (aromatic hydrocarbons and polyphenyls). The small volume changes at fusion show that no rotation can take place in the melt and it is argued that ordered clusters of intermediate size ($\gtrsim 10^{-4}$cm) must exist, even above T_m. The case is supported by viscosity data and comparisons with liquid crystals. In branched polyphenyls the activation energy for viscosity may double itself below T_m, but since supercooling is still possible it is suggested that the clusters present must differ from crystal nuclei. Transport and structure in ionic melts are considered briefly. R. O. DAVIES

532.7 : 530.145

7742. On the theory of quantum liquids. I. Surface tension and stress. M. TODA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 512–17 (*July*, 1955).

Pressure and stress of monatomic liquid is calculated by a modification of perturbation method in which the boundary of the system is subject to change. If the phase space distribution function of Wigner is used the expression becomes identical to classical stress tensor. The same method applies to the calculation of surface tension. The result is

$$\gamma = \frac{1}{A}\left\{ \frac{2\mathrm{Tr}\left[-\frac{\hbar^2}{2m}\sum_{j=1}^{N}\left(\frac{\partial^2}{\partial z j^2} - \frac{\partial^2}{\partial x j^2}\right)\right]\rho(x,x')}{\mathrm{Tr}\,\rho(x,x')} + \iint \frac{x_{12}^2 - z_{12}^2}{2r_{12}}\frac{d\phi(r_{12})}{dr_{12}} n(z_1)n(z_2)g(x_1, r_{12})\mathrm{d}x_1\,\mathrm{d}x_2 \right\}$$

in which $\rho(x, x')$ is the density matrix for the states with a definite liquid film with area A perpendicular to the z-axis. The first term represents quantum effect. And the second term is identical in form to the expression obtained by Harasima for classical liquids. It is shown that the relation $\gamma = \int (P - P_T)dz$ holds also for quantum liquid. Here P and P_T are respectively the pressure in the liquid and the pressure component tangential to the surface $z = \text{const.}$ Surface effect on ideal gases and comparison with experiments are also discussed. A.

532.7 : 537.531 : 535.43

7743. The theory of liquids and the prediction of diffuse X-ray scattering. G. FOURNET. *J. Phys. Radium*, **16**, *No.* 5, 395–400 (*May*, 1955) In French.

Evaluates Fourier components of liquid density distribution for different mean densities using a hard sphere model for the molecular interaction. Concludes that the theories allowing the calculations are still at a stage insufficient to allow the correct evaluation of the X-ray scattering. The errors of the evaluations decrease as $\sin\theta/\lambda$ increases. The positions of the intensity maxima are given correctly. R. S. PEASE

532.72

7744. Self-diffusion in liquid metals. G. CARERI AND A. PAOLETTI. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 161–5 (1955).

Measurements have been made of the self-diffusion coefficient in the liquids In, Sn and Pb. Results are expressed by giving D_0 and E_D in the formula $D = D_0 \exp(-E_D/RT)$. These values are compared with the same quantities for the corresponding solid and with E_η in the similar expression for viscosity. It is found that D_0 (solid) $\sim 5\times10^3 D_0$ (liq.) and that E_D (solid) $\sim 5E_D$ (liq.). Neither the Einstein formula nor the Eyring formula connecting D and η are consistent with the experimental data, but the former gives more reasonable values for the atomic radius. [In the discussion the authors present a table giving ionic conductivity constants (σ_0, E_σ) and viscosity constants for liquid and solid KCl, NaCl, KBr, AgCl and AgBr.] R. O. DAVIES

532.72

7745. Some remarks concerning the thermodynamics of diffusion phenomena. G. J. HOOYMAN. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 166–8 (1955).

It is shown that in a binary solution it is possible to define a diffusion coefficient which is independent of the choice of reference velocity. For a ternary system there are three independent coefficients and the macroscopic equation valid for an arbitrary reference velocity is derived. R. O. DAVIES

532.72

7746. On recent theories of thermal diffusion in liquids. K. F. ALEXANDER. Letter in *Physica*, **21**, *No.* 5, 446–8 (*May*, 1955).

In a binary system there are two independent kinetic heats of transfer while thermodynamically there can only be one. If it is assumed that in addition to diffusion of molecules by activated jumps, an additional collective motion is possible, then a formula can be derived which shows the compatibility of independent heats of transfer with the phenomenological theory. T. C. TOYE

532.74

7747. Calculation of intermolecular forces in liquids. A. E. RODRIGUEZ AND H. A. SANTA MARIA. *Rev. Univ. Nac. Eva Peron*, **5**, *No.* 1, *Paper* 3, 55–66 (*Oct.*, 1954) In Spanish.

The values of the force corresponding to a bimolecular potential $\phi(r)$, are calculated by means of the Born–Green integro-differential equation. This equation is based on Kirkwood's superposition hypothesis. Comparison with the ordinary bimolecular potential shows that for low temperatures Kirkwood's assumption is not appropriate. A.

532.74

7748. Linear association in solution. II. Analytical solution. R. GINELL AND J. SHURGAN. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1356 (*July*, 1955).

Two constants introduced previously [Abstr. 5928 (1955)] are determined by an analytical method and checked against values found graphically in the original example (phenathrene in ethanol). R. O. DAVIES

MECHANICS OF GASES 533

533.16 : 536.48

7749. Viscosity of HD and of He^3 between 14°K and 20°K. E. W. BECKER AND R. MISENTA. *Z. Phys.*, **140**, *No.* 5, 535–9 (1955) In German.

By measuring the viscosity of the gaseous hydrogen

isotopes it is found that values for HD are virtually equal to the arithmetic mean of H_2 and D_2 at 14–20°. At higher temperatures (60–90°) the value for HD is shifted towards D_2 by an amount which is approximately but not accurately equal to the mass effect in classical mechanics. The gaseous helium isotopes behave between 14 and 20° classically in so far as the viscosity of He^3 is lower than the viscosity of He^4. At temperatures lower than 4° it had been found previously that the viscosity of He^3 is higher.

R. EISENSCHITZ

533.5

7750. Compound metals in high-vacuum technique. W. ESPE. *Nachrichtentechnik*, **5**, *No.* 2, 69–74 (*Feb.*); *No.* 3, 121–5 (*March*, 1955) In German.

The importance of compound metals in sheet or wire form for high-vacuum purposes is discussed, and the preparation, properties, and utility of 16 examples are described, viz. Cu plated with Ni, Cu wire coated with Fe and Ni, sheet Fe plated with Al, or one side Al and the other Ni (the so-called PN-plate), sheet Ni with one side Al and TDPT–Fe the other (Pl-plate), chromed steel, Fe wire coated with Cu, Fe with Ni, FeNi (58/42) with Cu, FeNi (52/48) with Pt, Mo or W wire with gold, Mo wire with Pt, and W wire with Cu, compound metal solders, compound W with Cu, and W with Pb. Sixteen illustrations and 46 references. H. H. HODGSON

533.5

7751. Knudsen flow through a circular capillary. W. C. DEMARCUS AND E. H. HOPPER. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1344 (*July*, 1955).

This note is concerned with the solution of a linear integral equation which determines the frequency of collisions with the wall. A method is described by which the error of approximate solutions can be correctly estimated. Solution in terms of simple polynomials is shown to involve only minor errors.

R. EISENSCHITZ

533.5 : 531.788.7

7752. Ionic pumping mechanism of helium in an ionization gauge. L. J. VARNERIN, JR AND J. H. CARMICHAEL. Letter in *J. appl. Phys.*, **26**, *No.* 6, 782–3 (*June*, 1955).

In ultra-high vacuum systems atmospheric helium ions are trapped in the metallic film sputtered on to the glass surfaces from the electrodes during the outgassing procedure. Helium is therefore the major constituent of the gas pumped by a Bayard–Alpert ionization gauge. G. WITTENBERG

533.5 : 621.385 : 621.78

7753. Surface treatment of metals in vacuum technology. W. ESPE. *Slaboproudý Obzor*, **15**, *No.* 9, 443–7; *No.* 10, 482–91 (1954) In Czech.

A very comprehensive review covering: washing; pickling; forming the surface; sand-blasting; polishing; plating; sublimation of metal coating on to metal base; diffusion of one metal into the surface of a second; oxidation; carburizing; coating with carbon black; deposition of surface coating through thermal dissociation of halogen compounds; powdered metal coating; marking of metal parts. An international bibliography of 68 items is included. A.

533.59

7754. Versatile glass-to-metal vacuum seal. O. C. YONTS AND H. W. MORGAN. Letter in *Rev. sci. Instrum.*, **26**, *No.* 6, 619–20 (*June*, 1955).

Rubber or silastic O-ring vacuum seals for glass tubing are described. In conjunction with metal tubing of suitable diameter, this type of fitting is used in the construction of vacuum or gas flow systems which can be modified or disassembled in a few minutes. Pressures of 10^{-5} mm Hg are obtained regularly and it appears that even lower pressures can be reached. G. WITTENBERG

533.59

7755. Ultra-high vacuum valve. D. G. BILLS AND F. G. ALLEN. *Rev. sci. Instrum.*, **26**, *No.* 7, 654–6 (*July*, 1955).

An all-metal ultra-high vacuum valve is described. The valve has a continuously variable conductance from about 1 l/sec to less than 10^{-14} l/sec and presumably as small as desired. An equilibrium method of measuring small leakage conductances is described. A.

533.6.011

7756. Calculation of viscous flow around spheres at low Reynolds' numbers. T. PEARCEY AND B. MCHUGH. *Phil. Mag.*, **46**, 783–94 (*July*, 1955).

Detailed computations have been carried out, on the basis of Oseen's approximation to the hydrodynamic equations of motion, of the flow pattern around a uniformly translated sphere at Reynolds' numbers, R, of 1, 4 and 10. A strongly marked wake is apparent even at the lowest Reynolds' number. The boundary of the wake becomes more marked as R increases and is bounded by a thin layer in which the fluid motions are particularly small and of rapidly changing direction. No vortex is attached to the rear of the sphere even at $R = 10$, although the presence of a "boundary layer" to the front is well indicated. A.

533.6.011 : 778.37

Schlieren methods for photographing high-speed air flows. *See Abstr.* 8435

533.6.011.5

7757. Shock tube study of the flow past circular-arc airfoils using a Mach–Zehnder interferometer. K. ÔSHIMA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 571–7 (*July*, 1955).

Interferometer measurements are given of pressure distributions of circular-arc airfoils with thickness ratios. 10%, 15%, 20% at angles of attack, 0°, 1·6°, 3·2°, 4·8°, 6·4°, in the flow of Mach numbers, 0·75, 0·85, 0·95, 1·03, 1·1, 1·2, 1·3, 1·4, 1·55, 1·7, 1·9, with Reynolds' numbers based on chord length, $2{\cdot}2 \sim 1{\cdot}9 \times 10^5$. From these data, drag coefficients, lift coefficients and pitching moment coefficients were calculated for each case. These coefficients and lift-angle of attack curves are in good agreement with transonic similarity law. Results are also compared with other wind tunnel experiments. A.

533.6.013.22

7758. Experimental studies on the characteristics of isotropic turbulence behind two grids. H. TSUJI. *J. Phys. Soc. Japan*, **10**, *No.* 7, 578–86 (*July*, 1955).

To study the characteristics of isotropic turbulence

produced under various initial conditions and at high Reynolds' numbers, hot-wire measurements were made to determine the decay and the g-correlation of turbulence behind two grids, the upstream grid having a larger mesh length than the downstream one, in a 1·5m wind tunnel. The linear decay law, $\overline{u^2} \sim x^{-1}$, does not hold in the presence of a large-scale, slowly-decaying turbulence produced by the first grid ahead of the second grid. On the other hand, Lin's decay law, $\overline{u^2} \sim [x^{-1} + const.]$, which is supposed to be valid for the turbulence either behind a single grid or with superposed disturbances of low frequencies, is confirmed unless the large-scale turbulence produced by the first grid is overwhelmingly predominant, though the deviation from the self-preservation of correlation at large value of r is marked. The constant term in Lin's decay law, which expresses the deviation from the complete similarity, is negative for the single grid, but is positive in the presence of a superposed, large-scale turbulence. A.

533.6.013.22 : 534.232

7759. Measurements of the sound from circular cylinders in an air stream. J. H. GERRARD. *Proc. Phys. Soc. B*, **68**, *Pt* 7, 453–6 (*July*, 1955).

The frequency and intensity of the sound produced by flow past circular cylinders was investigated experimentally in the range of Reynolds' number in which a periodic shedding of vortices occurs. The cylinders were placed in a wind tunnel or on a whirling device. The sound resulting from the production of a vortex street was found to possess a dipole field which consisted of a predominant fundamental frequency accompanied by harmonics. The investigation was confined to the examination of the intensity and frequency of the fundamental. When this frequency was expressed as a Strouhal number Nd/U agreement was obtained between the acoustic frequency and that found, by other workers, in the wake itself. The sound intensity was found to vary with Reynolds' number in a similar way to the pressure coefficient at the rear of the cylinder. A.

MOLECULAR THEORY OF GASES 533.7

533.7

7760. Upon the definitions of a perfect gas. C. CODEGONE. *Atti Accad. Sci. Torino I*, **89**, 93–6 (1954–55) In Italian.

These are briefly considered and shown to be independent of each other and valid in restricted and non-coexistent conditions. J. J. PHIPPS

533.7

7761. Diffusion coefficients and law of molecular interaction. M. P. MADAN. *Indian J. Phys.*, **29**, *No.* 1, 11–19 (*Jan.*, 1955).

The experimental data on thermal diffusion and self-diffusion in conjunction with viscosity of various isotopic gases have been examined to study the law of molecular interaction on the basis of an exponential potential energy function, the collision integrals for which have been recently evaluated by Mason. The temperature dependence of thermal diffusion and viscosity has been used to obtain the intermolecular force constants. The results have been compared with those for a Lennard-Jones 12 : 6 potential and also with those given by Mason from virial, viscosity and crystal properties for an exp : six potential. The agreement is remarkably good. Utilizing the force constants obtained from thermal diffusion, coefficient of self-diffusion has been calculated and compared with the experimental results. From the considerations based on thermal diffusion data, a reason has been suggested for the unsuccessful behaviour of the exp : six potential for non-spherical molecules. The effect of second approximation to the thermal diffusion ratio on the intermolecular force constants has also been studied. It has been found that the conclusions are in accord with the author's statement made in an earlier paper. A.

VIBRATIONS . ACOUSTICS 534

534.113

7762. The flexural vibrations of an end-loaded vertical strip. R. F. S. HEARMON AND E. H. ADAMS. *Brit. J. appl. Phys.*, **6**, *No.* 8, 280–4 (*Aug.*, 1955).

An approximate equation is derived for the frequency of vibration of an end-loaded fixed-free strip having the loaded end vertically below the fixed end. This equation, which is an improvement on previous results, is compared with experiment, and a comparison is also made between the observed and predicted deflection curve of the vibrating strip. In both cases the agreement is satisfactory. A.

534.13 : 533.6.011.5

7763. Sound waves emitted by an air jet. M. MERLE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2055–7 (*May* 23, 1955) In French.

A supersonic air-jet emits sound waves which can be made visible by an optical method—striations using a heterodyned neon lamp as a source of illumination. The stroboscopic illumination of the lamp made it possible to observe the spectral distribution of sound at different frequencies. These were as follows:—(1) a spherical emission of sound propagated in a direction opposite to that of the jet and centred at the orifice of the jet; a second emission of sound of the same frequency is propagated in the same direction as the jet and visibly centred on the fourth or fifth striation where the jet ceases to possess a periodic aspect and becomes turbulent; (2) an emission normal to the jet of frequency double that in (1), but more feeble and narrow; (3) four directed beams of frequency the same as in (2), two directed forwards and two backwards relative to the direction of the jet. A. B. WOOD

534.213 : 536.33

7764. Mean free path in problems of acoustic and thermal radiation. C. CODEGONE. *Atti Accad. Sci. Torino I*, **89**, 66–7 (1954–55) In Italian.

The limiting conditions are established within which the definition of mean free path, as adopted in the study of the acoustics of halls, is satisfied for

thermal irradiation of a volume of an absorbing medium. J. J. PHIPPS

534.213.4

7765. Propagation of pressure waves in pipes. P. G. PEROTTO. *Atti Accad. Sci. Torino I*, **89**, 101–11 (1954–55) In Italian.

This is studied theoretically, using the analogy of electrical circuits containing distributed circuit elements, such as inductance, impedance, etc., which are defined for pressure waves, for the cases of: a pipe of finite length containing a viscous fluid, and a porous one with an attenuation independent of frequency. The faithful transmission of pressure waves is generally limited to tubes which are short compared with the wavelength. J. J. PHIPPS

534.213.4

7766. On Webster's horn equation. E. S. WEIBEL. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 726–8 (*July*, 1955).

A wave equation for the sound propagation through tubes is derived by means of Hamilton's variational principle. It is assumed that the wave fronts can be approximated by surfaces of constant stream potential; this is the only assumption made. The variational principle ensures that the best equation that is compatible with this assumption will be obtained. The equation has the form of Webster's horn equation, however its coefficients are defined differently. A.

534.213.4 : 532.51

7767. Wave propagation in elastic tubes filled with streaming liquid. G. W. MORGAN AND W. R. FERRANTE. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 715–26 (*July*, 1955).

A theoretical analysis of the propagation of pressure waves through elastic tubes filled with streaming incompressible viscous liquid is presented. The limiting results for the case of vanishing viscosity are compared with those for an inviscid liquid. The influence of the steady stream upon which waves are superposed, of wall inertia, and of Poisson's ratio are discussed. The analysis is restricted to tubes with thin walls, to waves whose amplitude is small and whose wavelength is large compared to the radius of the tube, and to liquids with sufficiently small viscosity. A.

534.22 : 532.7

7768. On the technique of ultrasonic velocity measurements in liquids. I. GABRIELLI AND L. VERDINI. *Ricerca sci.*, **25**, *No.* 5, 1125–31 (*May*, 1955) In Italian.

A method in using pulsed waves, the transit time of which is kept constant. The method is particularly suitable for measurements of velocity as a function of temperature. Measurements were carried out in benzene, from 18°C to the boiling point, and in palmitic acid, from 95 to 55°C, i.e. including the supercooled state. A.

534.22 : 532.7

7769. Variation of acoustic velocity with temperature in some low velocity liquids and solutions. G. W. MARKS. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 680–9 (*July*, 1955).

Acoustical velocities were measured at 500 kc/s in a number of organic liquids and binary solutions prepared therefrom. A precision ultrasonic interferometer was employed. For the most part sound velocities were found to vary linearly with temperature. Densities were determined at 20°C. Adiabatic compressibilities at 20°C were calculated and some conclusions drawn concerning the cohesive properties of certain of the solutions. The molecular sound velocity in a binary liquid solution is the sum of the products of the respective molecular sound velocities in the pure liquids by their corresponding mole fractions all at the same temperature. Where practicable, effective molecular radii were calculated from the data. The usefulness of the molecular weight of a liquid in predicting values of the temperature coefficient of velocity is discussed. Apparently many more experimental data are needed before an adequate theoretical analysis is possible. A.

534.22 : 534.23 : 535.41

7770. Microacoustic interferometer using 30 Mc pulses. R. A. MCCONNELL AND W. F. MRUK. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 672–7 (*July*, 1955).

In the described instrument ten-microsecond, 30 Mc/s carrier pulses reflected from a resonant layer allow a theoretical precision of 0·1% in making velocity determinations while using less than 0·1 cm³ of test liquid. By the same technique, ultrasonic absorption can be measured in highly dissipative liquids using layers about 0·1 mm thick. Water velocities observed at 30 Mc/s are presented along with values by others in the range of 0 to 93°C. $V = 1554 - 0{\cdot}0305(68{\cdot}4 - T)^2$ is proposed as the best empirical parabola to accommodate the available data, and an additional cubic correction formula is suggested. A.

534.22 : 537.226.2

7771. Ultrasonic velocities in polarized barium titanate ceramics. H. B. HUNTINGTON AND R. D. SOUTHWICK. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 677–80 (*July*, 1955).

Measurements have been made for both compressional and transverse waves, parallel and perpendicular to the axis polarization. Some variation in compressional velocity with the degree of binding was evident. The largest variation between the velocities for transverse waves causing shear amounted to nearly 12% and proved to be accounted for by electromechanical coupling. The compressional velocity parallel to the axis of polarization ran some 4% higher than that at right angles. Here, again, it appeared that the effect was caused principally by differences in electrical boundary conditions and that the constant field elastic constants varied only slightly with polarization. A.

534.222.2

7772. Shock waves in a dense medium. II. Experimental methods and some results of measurements made by the method of ultra-rapid radiography. J. DAPOIGNY, J. KIEFFER AND B. VODAR. *J. Rech. Cent. Nat. Rech. Sci.*, **6**, 260–70 (*June*, 1955) In French.

For Pt I, see Abstr. 5915 (1955). Techniques—mechanical, electromagnetic, photographic, schlieren, photoelastic, and a radiographic technique depending upon observation of the increased absorption of X-rays produced in a medium by the passage of

shock waves—are discussed, and the requisite apparatus for this last technique is described. Experimental results relating to the compressibilities of water and ice VI and VII, heptane, argon and Pyrex glass are given and discussed. A bibliography of 26 references is followed by corrections necessary to Pt I. J. S. G. THOMAS

534.222.2

7773. Simple triggering and marking system for measuring shock-wave velocities in tubes. E. G. THURSTON. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 735–7 (*July*, 1955).

A system consisting of specially designed pressure switches and a simple associated circuit is described for measuring the velocity of propagation of shock waves in tubes. A.

534.222.2

7774. Similarity solution for a spherical shock wave. R. LATTER. *J. appl. Phys.*, **26**, *No.* 8, 954–61 (*Aug.*, 1955).

The point-source, spherical shock wave moving into a constant density γ-law gas is considered in the limit of infinite shock strength from the point of view of the Richtmyer–von Neumann viscosity technique. A similarity solution of this problem is shown to exist and is obtained for various boundary conditions with $\gamma = 1{\cdot}4$. The solutions are obtained analytically in that part of the flow field not involving viscosity, and numerically in the other parts of the flow field. It is found that whereas all discontinuities of the physical parameters are removed by the viscosity there remain discontinuities in the slopes of these parameters at the shock front. It is indicated, moreover, that the complete flow field depends upon the form and magnitude of the viscosity. A.

534.222.2

7775. Geometrical acoustics. II. Diffraction, reflection, and refraction of a weak spherical or cylindrical shock at a plane interface. K. O. FRIEDRICHS AND J. B. KELLER. *J. appl. Phys.*, **26**, *No.* 8, 961–7 (*Aug.*, 1955).

The method of Pt I [Abstr. 9004 (1954)] is applied to the reflection and refraction of a weak spherical or cylindrical shock wave at a plane interface and by a plane slab. The method is also extended to apply to the diffracted wave which appears in these problems whenever total reflection occurs. From the results the leading terms in the asymptotic expansions for high frequency of the fields produced by periodic point or line sources over a plane interface are also obtained. These terms, which apply to electromagnetic as well as acoustic fields, are in exact agreement with results previously obtained by much more complicated methods. A.

534.222.2

7776. Weak detonations and condensation shocks. W. H. HEYBEY AND S. G. REED, JR. *J. appl. Phys.*, **26**, *No.* 8, 969–75 (*Aug.*, 1955).

The absence of weak detonations in available experience is felt to pose a problem since the well-known rapid condensation processes encountered in the flow of expanding gases have all the characteristics and present, in fact, examples of weak detonations. As such, they would suggest that the initiation mechanism producing weak detonations will have to be different from that commonly adopted for strong detonations. The physical aspects of rapid condensation processes are discussed and compared with the conditions obtained by Friedrichs for the existence of weak detonations. A.

534.222.2

7777. On the reflection of shock waves from an open end of a duct. G. RUDINGER. *J. appl. Phys.*, **26**, *No.* 8, 981–94 (*Aug.*, 1955).

The readjustment of the mean exit pressure to its steady-flow equilibrium level, following the arrival of a shock wave at an open end of a duct, has been investigated. For a cylindrical duct in which the gas is initially at rest, a solution based on acoustic theory was obtained in the form of a Fourier integral. The nature of this solution was established as a series of damped harmonic oscillations superposed on an exponential pressure decay. The actual pressure decay curve was obtained by numerical integrations. The same problem was also attacked experimentally using a shock tube of 3·23 in. i.d. From pressure records taken some distance from the open end, the "effective" exit pressure was derived. It was found that the exit pressure deviates appreciably from its steady-flow equilibrium value during a time in which a sound wave could travel about three duct diameters. Satisfactory agreement between theory and experiment was observed for shock pressure ratios up to about 1·9 (in air) although, near this limit, significant deviations owing to wall friction were observed toward the end of the pressure decay region. For still stronger shocks, the influence of the decay time on the phenomena inside the duct becomes unimportant while friction effects dominate. The possible significance of the lag in the establishment of steady-flow boundary conditions in practical applications is discussed, in particular, for cases where the acceleration of the gas by the reflected expansion wave may be of importance. A.

534.222.2 : 536.46

7778. Luminous zone in the detonation of equimolar acetylene-oxygen. A. L. BENNETT AND H. W. WEDAA. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1359–60 (*July*, 1955).

Detonation velocities and light outputs have been measured in 12 cm dia. tubing coupled to 10 cm square tubing. The detonation velocity fell from 2772 m/sec at 50 mm Hg to 2612 at 2 mm, and the peak light output from 29 to 6 units; the integrated light output remaining approximately constant. Light profiles are shown. R. C. MURRAY

534.222.2 : 539.132

7779. Dissociation of nitrogen in shock waves. J. P. TOENNIES AND E. F. GREENE. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1366 (*July*, 1955).

Measurements of the velocity of incident and reflected shock waves in nitrogen agree fairly well with those calculated assuming the dissociation energy of nitrogen to be 225 kg-cal/mole, and support this figure against that of 170 kg-cal/mole sometimes suggested. The method is thought to be a suitable one for investigating the properties of gases, particularly at high temperatures. R. C. MURRAY

534.23

7780. The absorption of ultrasonic waves in iron-Armco and Plexiglass. N. F. Otpushchennikov. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 3, 371 (1955) In Russian.

In the range 0·66–10Mc/s the absorption coefficient varies linearly for iron-Armco and as the square root of the frequency for Plexiglass. J. M. HOUGH

534.23

7781. Attenuation in shallow-water propagation due to an absorbing bottom. E. T. Kornhauser and W. P. Raney. *J. Acoust. Soc. Amer.*, **27**, *No.* 6, 689–92 (*July*, 1955).

The attenuation of normal modes in a two-layered fluid medium due to absorption in the lower semi-infinite layer is calculated under the assumption that this absorption is small. The result obtained gives the attenuation coefficient for each mode as the product of the absorption coefficient for plane waves in the absorbing layer and a dimensionless function of wavelength and layer depth. Curves of this dimensionless function are plotted for the first modes in cases typical of propagation in shallow water over a sand and a mud bottom. The results indicate a very rapid decrease in attenuation as the frequency rises above the cutoff frequency, where it is just equal to the bottom absorption. At higher frequencies the attenuation varies as $(n^2\lambda^3/H^3)\alpha$, where n is the mode number, λ the wavelength, H the water depth, and α the absorption coefficient in the bottom (α may itself be a function of frequency). The latter result is also derived by a less rigorous method. A.

534.23

7782. Tank wall lining for underwater sound use. P. Tamarkin and R. K. Eby. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 692–8 (*July*, 1955).

An anechoic lining for underwater sound use can be made from waterproofed, rubberized, horsehair matting. It decreases the reflectivity 20 db below that obtained from a steel wall over a frequency range from 100 kc/s to 400 kc/s and for a wide range of angles of incidence. It is inexpensive, easily installed, and can be used for several 8-hour periods before additional waterproofing is necessary. A.

534.23

7783. Effect of pressure on sound propagation in water. T. A. Litovitz and E. H. Carnevale. *J. appl. Phys.*, **26**, *No.* 7, 816–20 (*July*, 1955).

Measurements of the ultrasonic absorption of water have been made up to pressures of 2 000 kg/cm^2. The data show that both the shear and compressional losses decrease as the pressure is raised. Comparison of these results with the values predicted by Hall's theory of sound absorption in water shows that the theory must be modified to be in agreement with the experimental data. The modification consists of assuming that the open or ice type of packing is associated with the higher free-energy state. If this modification is made, the observed data is in excellent agreement with theory. This result leads to the conclusion that even at 0°c less than 30% of the molecules in water are arranged in the ice type of packing. The results also indicate that the free-energy difference between the two states of packing in water is temperature dependent. A.

534.23 : 535.435

7784. Sound absorption in liquids in relation to light scattering data. S. Parthasarathy and A. P. Deshmukh. *Ann. Phys.* [*Leipzig*] **15**, *No.* 7–8, 417–24 (1955).

Ultrasonic absorption coefficient (theoretical) and light scattering properties of liquids have been correlated in a large number of liquids. It is observed that there is a definite relationship in the manner in which the values of sound absorption coefficient α/v^2, light scattering intensity I and the depolarization factor ρ change from liquid to liquid. The study reveals a linkage between optical anisotropy and sound absorption and suggests strongly the existence of sonic anisotropy of molecules at high frequencies. A.

534.23 : 536.632

7785. The relationship between optically measured ultrasonic absorption and specific heat. S. Parthasarathy, C. B. Tipnis and M. Pancholy. *Z. Phys.*, **140**, *No.* 5, 504–9 (1955) In German.

Using an optical method α has been determined for a number of different liquids. It is shown that the ratio α obs./α theor. is large when the ratio of specific heats γ is also large. A formula relating α and γ is quoted which has been derived by Parthasarathy and Guruswamy from theoretical considerations (in course of publication). T. C. Toye

534.23 : 548.7

7786. Relaxations in the attenuation of single crystal lead at low temperatures and their relation to dislocation theory. W. P. Mason. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 643–54 (*July*, 1955).

Measurements of the attenuations of face-centred metals by Bordoni have shown attenuation peaks at low temperatures. By using the measurements of Bömmel on single-crystal lead it can be verified that this is a relaxation and values can be obtained for activation energies and frequency terms. It is shown that the measured results correlate well with a relaxation due to the displacement of a dislocation from one atomic line to an adjacent one against the limiting shearing stress of the crystal. The limiting shearing stress measured for four face-centred metals is in good agreement with theoretical calculations of Cottrell. A higher temperature loss is also measured which increases exponentially with the temperature. It is shown that this term is due to breakaway of the dislocation from its impurity pinning points due to thermal agitation. This breakaway abstracts energy from the vibration and produces a loss independent of the frequency but increasing with temperature since more breakaways occur at higher temperatures. The activation energy of breakaways correlates well with the binding energy of impurity atoms. A.

534.232

7787. On the radiation impedance of an array of finite cylinders. D. H. Robey. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 706–11 (*July*, 1955).

A general expression for the radiation impedance of the qth source in an array of n sources has been obtained in terms of Green's functions. It is applicable to finite sources or to sources which are mounted

in finite baffles provided the Green's function can be found. The theory is applied to an array of finite cylinders which form part of an infinitely long rigid cylindrical baffle. If $ka \ll 1$, the radiation resistance of each member can easily be expressed in terms of sine integrals. Curves showing the radiation resistance of each member of an array of five cylinders are given. The effect of varying the separation is also shown. A.

534.232

7788. On the radiation impedance of the liquid filled squirting cylinder. D. H. Robey. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 711–15 (*July*, 1955).

The impedance presented to the inside surface of a hollow, radially vibrating, liquid filled cylinder of length l which is mounted in the aperture of a rigid wall of thickness l has been determined. It was assumed that radiation from the ends of the cylinder into the infinite liquid media (water) takes place symmetrically with respect to the plane midway between the ends of the cylinder. The liquid within the cylinder need not be the same as the liquid outside the cylinder. Although the impedance at any frequency can be obtained from the results, an approximation is introduced which is valid when the wavelength in the liquid within the cylinder is such that $ka \leqslant \pi/2$ (k being the wavelength constant and a the inside radius of the cylinder). Under these circumstances it is found that the output power drops to zero whenever the length of the cylinder equals $n\lambda$, where n is an integer and λ is the wavelength of sound in the contained liquid. A.

534.232 : 533.6.013.22

Sound from circular cylinders in an air stream. *See Abstr.* 7759

534.24 : 534.26

7789. Nonspecular reflection of sound from a sinusoidal surface. H. S. Heaps. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 698–706 (*July*, 1955).

The acoustical radiation scattered from a sinusoidal surface of zero pressure insonified by an obliquely incident plane wave of sound is obtained as an infinite series of waves whose coefficients may be determined by means of a recurrence relation. The corresponding analysis is presented for the case of a spherical source of radiation. At points sufficiently remote from the surface only a finite number of terms need be included. Each coefficient in the series is itself an infinite series which converges most rapidly when the height of the surface corrugations is small compared to the wavelength of the incident sound. Application is made to determine the average intensity and fluctuation of the sound reflected from a travelling sinusoidal boundary. The degree of roughness required to destroy the effect of Lloyd mirror fringes is discussed in terms of the ratio of the surface height and wavelength to the wavelength of the incident sound. A.

534.26 : 539.32

Determination of elastic constants of solids by ultrasonic diffraction methods. *See Abstr.* 8318

534.321.9 : 532.528 : 532.7 : 541.14

7790. Physico-chemical aspects of chemically active ultrasonic cavitation in aqueous solutions. O. Lindström. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 654–72 (*July*, 1955).

Quantitative measurements have been performed on some fundamental phenomena caused by ultrasonic cavitation, i.e. the synthesis of hydrogen peroxide, the oxidation of potassium iodide, the decomposition of carbon tetrachloride, the degassing action and the evolution of heat in connection with the cavitation process. The experiments were made under controlled and defined acoustic conditions (standing waves, progressive waves, and non-resonance) and the influences by various important factors (acoustic intensity, has content) have been evaluated. Tentative theories of the cavitation process and allied phenomena are evaluated on the basis of the experimental results. Cavitation chemistry is found to be similar to γ-radiation chemistry (pH-dependence of the yield of hydrogen peroxide, oxidation of solutes, necessity of oxygen). Cavitation is assumed to be preceded by a homogeneous nucleation process in which a germ or gas nucleus is being formed by rupture of the liquid around this germ. Ionization of some of the gas molecules entrained in the cavity will take place in order to establish the electric charge of the surface of the cavity. Two hydrogen peroxide molecules are formed for every ionized oxygen molecule. It is supposed that in the case of oxygen a cluster is formed by the combination of two water molecules and a positive oxygen ion. This cluster yields on decomposition at the neutralization two hydroxyl radicals and one excited hydrogen peroxide molecule. The rate of cavitation seems to be independent of (1) the gas concentration (above the threshold concentration), (2) the pressure amplitude (above the threshold amplitude and within the region of cavitation), and (3) the nature of the dissolved gas (provided the gas may initiate homogeneous cavitation at all). These features indicate that properties of the liquid are rate determining when the various threshold requirements are fulfilled. A tentative picture of the nucleation process is presented, which seems to satisfy these conditions. The degassing action in an ultrasonic field proceeds to half saturation practically independent of the intensity. A method for cavitation dosimetry is described. A.

534.512.1

7791. A study of powder and granular ridges in a sound field. M. D. Waller. *Proc. Phys. Soc. B*, **68**, *Pt* 7, 462–71 (*July*, 1955).

The author's vibrating plate method of forming powder ridges on a flat surface [Abstr. 799 (1955)] has now been used to study the phenomenon with graded powders of different densities and at different frequencies and intensities of vibration of the sound field. It is found that the distances between the ridges increase roughly as the square root of the particle diameters, a result which is in agreement with Bagnold's observations with powders under oscillating water, but needs still to be taken into account of, in connection with Kundt powder ridges. "Granular" ridges, one particle wide, are nearer together than powder ridges, the spacings of which increase with the amount of powder which is present. Much larger intensities are required to move dense powders

than light powders; the resulting spacings are, however, approximately the same. The variables which have most influence on the spacing are the diameters of the grains and the frequency of the vibration, not the intensity. These matters are discussed in relation to the phenomenon of "wavy" ridges. Experiments in which larger objects, as well as powders, are introduced into the field are also described. A.

534.612.2 : 621.395.616

7792. The condenser microphone as an acoustic standard. M. S. HAWLEY. *Bell Lab. Record*, **33**, *No.* 1, 6–10 (*Jan.*, 1955).

This type of microphone qualifies as a standard because it has a uniform and wide-range response-frequency characteristic, it can be made small, it is stable with atmospheric conditions and time, and it has a high acoustic impedance. The 640AA microphone, used for this purpose, is described in detail. One application is the measurement of performance of a loudspeaker; another is its use as an artificial ear for testing the transmitters of hand-sets. The signal/noise ratio for high and low sound pressures is discussed in detail. The use of the reciprocity method for calibration is mentioned. H. G. M. SPRATT

534.7

Physiological acoustics. Hearing. *See also under* "Medical science. Human physiology." Decimal classification 612.85

534.78

7793. On measuring speech intelligibility. H. SCHNEIDER. *Frequenz*, **9**, *No.* 6, 199–205 (*June*, 1955) In German.

The method described is claimed to be novel in that it is more economical, particularly where two different transmission channels are to be compared. Logatoms are recorded on sound tape and speech errors are eliminated prior to measurement. The possibility of repeating playback is advantageous for the conditions of the experiment and to the observer. Suggestions are made for developing the method into an economical and readily manipulated standard procedure. Two examples are presented. T. J. REY

534.78

7794. Effect of duration on the perception of voicing. P. DENES. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 761–5 (*July*, 1955).

Describes an investigation of the effect of sound duration on the perception of a linguistic characteristic, the recognition of phonemes. A pair of single-syllable words was selected which consisted of identical phoneme sequences, except for the final phoneme which was either the voiced or unvoiced version of the same articulation. Different versions of these words were synthesized with all possible combinations of four different vowel durations and five different final consonant durations. In all cases the sound wave corresponding to the final consonant was inharmonic and identical except for duration. These synthesized words were recorded and presented to a group of 33 listeners who had to judge whether they heard the final consonant as a voiced or as an unvoiced sound. The results clearly show that the relative durations of vowel and final consonant can be used as a cue for hearing the final sound as voiced or unvoiced. This demonstrates that, in certain circumstances, non-spectral characteristics such as duration can serve as the basis for phoneme recognition. It also gives an example of a cue for sound recognition which, due to its relative nature, can be perceived only when it appears in a sequence of phonemes and not when the sound is pronounced in isolation. A.

534.78

7795. Duration and intensity as physical correlates of linguistic stress. D. B. FRY. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 765–9 (*July*, 1955).

The experiments reported in this paper are an attempt to explore the influence of certain physical cues on the perception of linguistic stress patterns. The material chosen was a group of English words in which a change of function from noun to verb is commonly associated with a shift of stress from the first to the second syllable. Spectrograms were used to determine the vowel duration and intensity ratios which occur in these words and this information was applied in making up a test in which listeners' judgments of stress could be correlated with variations in the duration and intensity ratios. The results of the experiments show that duration and intensity ratios are both cues for judgments of stress and that, in the material studied, duration ratio is a more effective cue than intensity ratio. A.

534.78

7796. Acoustic loci and transitional cues for consonants. P. C. DELATTRE, A. M. LIBERMAN AND F. S. COOPER. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 769–74 (*July*, 1955).

Previous studies with synthetic speech have shown that second-formant transitions are cues for the perception of the stop and nasal consonants. The results of those experiments can be simplified if it is assumed that each consonant has a characteristic and fixed frequency position, or locus, for the second formant, corresponding to the relatively fixed place of production of the consonant. On that basis, the transitions may be regarded as "movements" from the locus to the steady state of the vowel. The experiments reported in this paper provide additional evidence concerning the existence and positions of these second-formant loci for the voiced stops, *b*, *d* and *g*. There appears to be a locus for *d* at 1 800 c/s and for *b* at 720 c/s. A locus for *g* can be demonstrated only when the adjoining vowel has its second formant above about 1 200 c/s; below that level no *g* locus was found. The results of these experiments indicate that, for the voiced stops, the transition cannot begin at the locus and go from there to the steady-state level of the vowel. Rather, if the appropriate consonant is to be heard, the first part of the transition must be silent. The voiced stops are best synthesized by making the duration of the silent interval equal to the duration of the transition itself. An experiment on the first formant revealed that its locus is the same for *b*, *d* and *g*. A.

534.81

7797. Touch-sensitive organ based on an electrostatic coupling device. H. LE CAINE. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 781–7 (*July*, 1955).

A device for coupling generators to sound systems in electric musical instruments is described, particu-

larly in connection with its use in a touch-sensitive keyboard. The construction of such a keyboard is shown to be quite straightforward. Many well-known types of generators and any timbre control system may be used. The musical value of a touch-sensitive action is difficult to assess, but the writer is impressed favourably. A.

534.839

7798. Type testing and calibration methods for production phonometers with particular regard to the measurement of traffic noise. S. Kitsopoulos. *Bull. Assoc. Suisse Elect.*, **46**, *No.* 8, 372–6, 389 (*April* 16, 1955) In German.

The basic principles and constituent parts of the phonometer are reviewed. Some controlled tests on traffic noise showed a difference of 10 db between light and heavy motor vehicles and established the fact that the bulk of the sound energy lies below 1 kc/s. Basic levels were set into the instruments by comparison with a standard microphone in an anechoic room. At the same time the effects of battery voltage and temperature changes were investigated. For calibration purposes a falling-shot noise source was chosen because of its wide band width and its independence of temperature and moisture changes.

H. G. M. SPRATT

534.839 : 621.395.62

7799. French National Railways [acoustic] noise recording car. L. Gaspard. *Bull. Soc. Franç. Elect.* (*Sér.* 7) **5**, 197–204 (*April*, 1955) In French.

The principles of the sound-proofing of rolling stock are summarized and criteria are suggested for noise levels tolerable to passengers. Electro-acoustic apparatus for noise measurements on rolling stock are described and their suitability for this purpose is discussed. Noise-measuring equipment actually in use on the French rlys is described and illustrated by schematic diagrams of the equipment and views of the installation on the vehicle. The method of testing is outlined and examples of results obtained are shown graphically [e.g. relative effectiveness of different types of sound-proofing material, comparison of noise from bogies with steel tyres and rubber (pneumatic) tyres]. A. T. DOVER (R)

534.843

7800. Acoustics of low rooms and of tunnels. J. Brillouin. *C.R. Acad. Sci.* [*Paris*] **240**, 2210–12 (*June* 6, 1955) In French.

The ordinary laws of reverberation are not applicable in the cases of large relatively low rooms and tunnels. In these cases the intensity level N (in dbs) of the sound emitted by a source decreases linearly as a function of distance r, thus $dN = -kdr$. The object of the present investigation is to evaluate theoretically the attenuation constant k and to determine the law of increase of sound intensity when a source begins to emit sound. A. B. WOOD

534.843

7801. Comparison of objective and subjective observations on music rooms. J. Blankenship, R. B. Fitzgerald and R. N. Lane. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 774–81 (*July*, 1955).

Presents a comparison of the physical and acoustic measurements in several music rooms at The University of Texas with the subjective reactions of the musicians working in these spaces. Emphasis is placed on the musicians' viewpoint in regard to desirable room characteristics. A.

534.843

7802. Articulation scores for two similar, reverberant rooms, one with polycylindrical diffusers on walls and ceiling. L. A. Jeffress, R. N. Lane and F. Seay. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 787–9 (*July*, 1955).

Two rooms of about the same dimensions, one a rectangular parallelopiped, and one having polycylindrical walls and ceiling, were measured for reverberation times and for speech articulation. No significant differences were found in either characteristic. Since one of the rooms should provide a more diffuse sound field than the other, it can be tentatively concluded that diffusion may have little influence on speech intelligibility. Both rooms exhibited rather poor articulation scores as might have been predicted from their reverberation times. A.

OPTICS . RADIATION . SPECTRA 535

535.14

7803. Coincidences between photons contained in coherent light rays. A. Ádám, L. Jánossy and P. Varga. *Acta phys. Hungar.*, **4**, *No.* 4, 301–15 (1955) In Russian, with summary in English (200 words).

The authors investigated whether or not photons contained in coherent rays are independent. A light ray falling on a semi-transparent mirror splits into two coherent components. Registering the photons of these components by two electron multipliers, it was investigated, whether or not the electron multipliers do give rise to coincidence discharges. It was shown that, making use of an amplifier of usual resolving power, that is, of the order of 2μsec, the arrangement is suitable for detecting systematic coincidences if such coincidences occur. In the actual experiment the numbers of coincidences obtained with the multipliers were compared (1) when the multipliers were illuminated by coherent beams, and (2) when they were illuminated by equally strong incoherent beams. The coherent and incoherent illumination was changed in the first experiments in two-minute intervals, in the later experiments by an automatic arrangement at every 1/100 of a second. This fast interchange was employed in order to eliminate as far as possible the effect of slow variations of the sensitivity of the apparatus. The experiments did not show any difference between the effects of coherent and incoherent light. Thus it can be safely assumed that all the coincidences recorded were accidental coincidences. Moreover, allowing even for fluctuations amounting to three times the standard error, the measurements would be incompatible with an assumption that more than 0·6% of the photons behaved in an anomalous way. A.

535.2

7804. A table of the radiative opacities of a number of gas mixtures. G. Keller and R. E. Meyerott. *Astrophys. J.*, **122**, *No.* 1, 32–42 (*July*, 1955).

Rosseland mean opacities have been computed for gas mixtures at temperatures ranging from 10^5 to

2×10^7 degrees and for a range of densities dependent upon the temperatures. Thirteen mixtures, most of which are rich in hydrogen and helium, have been investigated. A.

535.23

7805. Radiation from a hollow cylinder. M. G. ROSSMANN. Letter in *Brit. J. appl. Phys.*, **6**, *No.* 7, 262–4 (*July*, 1955).

Making use of the mathematical analogy in the theory of molecular flow and geometrical optics [Abstr. 8980 (1954)] an expression for the intensity of radiation from a hollow cylinder is derived. The result is in agreement with previous work by Buckley (1934). R. EISENSCHITZ

535.23.08

7806. The construction of two infra-red recording spectro-radiometers. E. C. LEISEGANG AND A. J. ROSSOUW. Note in *J. sci. Instrum.*, **32**, *No.*7, 286–7 (*July*, 1955).

Dimensions of an instrument with double pass monochromator, chopped beam and pen recorder. G. F. LOTHIAN

535.241.33

7807. Luminous microflux standard. B. W. ENGSTROM. Letter in *Rev. sci. Instrum.*, **26**, *No.* 6, 622–3 (*June*, 1955).

A 10-micro-lumen standard source is described, consisting in a tungsten-filament source combined with a light-reduction system, based on reflection from front-surface-aluminized convex mirrors. The reflection characteristics are uniform within the spectral range, 3000–12000 Å. Accurate calibration may be derived by calculation; and a range of light-reduction factors may be obtained by the use of different plane, and convex, mirror combinations. D. R. BARBER

535.247.4

7808. Apparatus for recording the variations of luminous intensity of illuminating devices. L. MELONI. *Atti Fond. Ronchi*, **10**, *No.* 2, 87–90 (*March–April*, 1955) In Italian.

Describes photoelectric apparatus for obtaining a record of the illumination from, and therefore the luminous intensity of such devices as rockets, flares and the like. A photo-voltaic cell with colour-correcting filter is used in combination with a d.c. amplifier which is described in detail. J. W. T. WALSH

535.247.4

7809. Uses of the globe photometer. W. R. G. ATKINS AND H. H. POOLE. Letter in *Nature* [*London*] **175**, 1003 (*June* 4, 1955).

A photocell enclosed in a diffusing globe can be used to measure the illumination at a shaded point as a percentage of the total diffuse light in the open. J. W. T. WALSH

535.314

7810. Angle of incidence as a function of the angle of deviation and the refractive indices. S. MOHOROVIČIĆ. *Optik*, **12**, *No.* 6, 281–2 (1955) In German.

The law of refraction at a plane surface is transformed so that the angle of incidence may be calculated directly for some required angle of deviation. R. W. FISH

535.317

7811. Anamorphic image formation. W. HANKE. *Optik*, **12**, *No.* 7, 322–8 (1955) In German.

By a double optical projection, one rectangle may be transformed into another, with the magnifications different along adjacent sides. The mathematical relationships governing the transformation are given and the limitations imposed by the angular field of the projector lenses. R. W. FISH

535.317 : 515

7812. Optical transformation of the general quadrilateral into a parallelogram. W. HANKE. *Optik*, **12**, *No.* 7, 316–21 (1955) In German.

A method of optical projection, suitable for use in photogrammetry, is given to allow any quadrilateral to be transformed into a parallelogram without loss of definition. R. W. FISH

535.317.1

7813. The frequency response of a defocused optical system. H. H. HOPKINS. *Proc. Roy. Soc. A*, **231**, 91–103 (*July* 19, 1955).

The response of a defocused aberration-free optical system to line-frequencies in the object is studied analytically. Curves are given showing the response as a function of line-frequency for a range of values of defect of focus. A comparison is made with the results to be expected from geometrical optics. A tolerance for defect of focus is obtained, which accords well with published experimental results. Both circular and rectangular apertures are considered. A.

535.317.1

7814. Studies on the image formed by lenses. II. The effect of spherical aberration on optical images. G. KUWABARA. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 625–36 (*Aug.*, 1955).

For Pt I, see Abstr. 4495 (1955). The location of the best focuses and the image quality of lenses with spherical aberration were determined by measuring the intensity distribution of light in the line image, and the results were compared with the theoretical results obtained by wave optics. In the presence of primary spherical aberration, $S_1 \equiv \delta s_m/(F^2\lambda)$ is introduced as a parameter, where δs_m is the marginal spherical aberration, F is the f-number, and λ is the wavelength. The best focus lies: (1) midway between the paraxial and marginal foci for $S_1 < 36$; and (2) away from the paraxial to the marginal foci by about $(5\cdot6/S_1)^{\frac{1}{2}}$ for $S_1 > 36$. In the presence of primary and secondary spherical aberration with the maximum value δs_z, the location of the best focuses, δf_0 measured from the paraxial focus and the definition $|\Gamma|^2$ for the line image at the corrected aperture F_0, are given by a parameter $S_2 \equiv \delta s_z/(F_0^2\lambda)$ as

$$|\Gamma|^2 = 1 - 1\cdot955\times10^{-4}S_2^2 \quad \delta f_0 = 0\cdot80\delta s_z, \quad \text{for } S_2 < 20,$$

and

$$|\Gamma|^2 = 5\cdot35(1/S_2)^{\frac{3}{2}} \quad \delta f_0 = [1 - (2\cdot62/S_2)^{\frac{1}{2}}]\delta s_z, \quad \text{for } S_2 > 45.$$

The best type of correction for a given value of the secondary coefficient of aberration is also discussed. A.

535.317.6

7815. The determination of an optimum lens system. F. WACHENDORF. *Optik*, **12**, *No.* 7, 329–40 (1955) In German.

A method is given which allows the lens designer to determine the system with the smallest circle of confusion. R. W. FISH

535.317.6

7816. Astigmatism of skew pencils in optical systems containing toric surfaces. W. WEINSTEIN. *J. Res. Nat. Bur. Stand.*, **54**, *No.* 5, 251–62 (*May*, 1955).

Toric refracting surfaces are of importance in spectacle lenses and in anamorphotic photographic and projection lenses. A method of tracing skew rays through such systems is derived. The astigmatism in pencils centred about these skew rays is determined. R. W. FISH

535.317.6

7817. Ultra high speed skew-ray tracing. G. BLACK. Letter in *Nature* [*London*] **176**, 27 (*July* 2, 1955).

The use of a new experimental Manchester Mk II digital computer to trace skew rays is described. The trace takes about 0·1 sec per ray surface. Some details of the storage facilities of the machine are given. R. W. FISH

535.329

7818. Study of the anomalous dispersion of lead iodide. S. NIKITINE AND G. PERNY. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 24, 2298–300 (*June* 13, 1955) In French.

A thin single crystal film, observed at the temperature of boiling N_2, shows a strong absorption line at 4945 Å and continuous absorption at shorter λ's. The interference fringes observed at slightly longer wavelengths are non-uniformly spaced because of the varying refractive index (n). Positions of the fringes are used to give a qualitative n, λ curve. It is hoped to make the measurements absolute. G. F. LOTHIAN

535.33 : 535.417

7819. High resolution in the infrared by interferometry. Unambiguous display without overlapping orders. J. H. JAFFE, D. H. RANK AND T. A. WIGGINS. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 636–43 (*Aug.*, 1955).

The Fabry–Perot interferometer has been adapted for very high-resolution spectroscopy in the near infrared. At 1·5μ a pair of lines separated by 0·043 cm^{-1} was fully resolved. This represents a sixfold improvement over anything that has been achieved hitherto at this wavelength. An important new method emerged which has applications to both emission and absorption spectroscopy in general. By its means a region many times the spectral range of the interferometer can be displayed directly and unambiguously without overlapping orders. A.

535.33.03

7820. The influence of the physical state of an element on its optical spectra: the case of ferrosilicon and ferroboron. H. TRICHÉ AND J. SIMON. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2064–6 (*May* 23, 1955) In French.

A brief discussion of certain enhancement effects in the Tesla discharge excitation of the spectra of Fe–B and Fe–Si. The effects may be explained by differences in the speed, etc., of volatilization from cathodes with varying physical properties. J. D. CRAGGS

535.33.03

7821. The emission of the "λ4050 Å" bands and an associated violet continuum in oxyacetylene flames. G. V. MARR AND R. W. NICHOLLS. Note in *Canad. J. Phys.*, **33**, *No.* 7, 394–6 (*July*, 1955).

A strong continuum with main maximum at 4000 Å and perhaps a second maximum at 4300 Å appears under the same conditions as the 4050 bands and is probably also due to C_3. A. G. GAYDON

535.33.03

7822. The use of a shock tube to obtain line broadening data. E. B. TURNER. *Stellar Atmospheres Conference* [*Indiana*] 52–62. See Abstr. 7656 (1955).

The possibilities of producing temperatures within the range of astrophysical interest by means of a shock tube, designed primarily for the calibration of piezoelectric strain gauges, was first reported by Perry and Kantrowitz (1951). The shock-wave front is luminous for very strong shock waves, even if the gas behind the front is not luminous; and the degree of excitation represented by the spectrum of the luminous gas, when analysed by a spectrograph, is similar to that in the spectra of stellar atmospheres, except that all lines are now seen in emission. Estimated temperatures observed in a luminous H–Ne column ranged from 11 000 to 12 000° K, the lines H_β, H_γ and H_δ being broadened by a strong first-order Stark effect by as much as 80 Å (half-width), the Ne lines remaining sharp. D. R. BARBER

535.33.07

7823. A comparison of the different mirror mountings used in spectrophotometry. H. WIHLM. Letter in *Optica Acta*, **2**, *No.* 1, 50–1 (*April*, 1955) In French.

Available methods of disposing mirrors in the optical systems of single- and double-monochromators are compared from the standpoint of spherical-mirror aberrations likely to dilute the spectral purity of the emergent radiation. The results may be applied also to systems employing parabolic reflectors. D. R. BARBER

535.33.07

7824. New sample holder for reflection measurements with the Beckman model DU spectrophotometer. G. TONNQUIST. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 7, 582 (*July*, 1955).

535.33.07

7825. Modification of the Gier blackbody reflectometer for use with the Beckman IR-3 spectrometer. W. L. STARR AND E. R. STREED. Letter in *J. Opt. Soc. Amer.*, **45**, *No.* 7, 584 (*July*, 1955).

A modification of the system of Gier [Abstr. 9131 (1954)] with longitudinal rotation about a water-cooled bearing. G. F. LOTHIAN

535.331/.332

7826. Emission characteristics of vacuum spark discharges. III. Aluminium and carbon spectra in the visible region. J. C. WAHR, W. W. MCCORMICK AND R. A. SAWYER. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 665–9 (*Aug.*, 1955).

For Pt II, see Abstr. 5429 (1954). The intensity of a number of lines of Al I, Al II, Al III, C II and C III, in the visible region, has been measured as a function of the peak current in a vacuum spark discharge at

values of self-inductance ranging from 2·4 to 45 μhenry. The spark was energized from a bank of condensers, with a total capacitance of 21·6 μf, charged to five different voltages from 5·3 up to 20·5 kV. The line spectrum is accompanied by a continuum which is most intense during the first oscillation of the spark current and then decays rapidly. At large currents most of the apparent line intensity during the first current cycle comes from the continuous background. At values of inductance above 2·4 μhenry, the intensity of the lines of Al I and C II increases about linearly with the peak current. However, at 2·4 μhenry the intensity of the Al III lines is enhanced in the neighbourhood of 32 kA as had been observed in earlier work. At a particular current, the intensity is always larger at the larger inductances, but at constant voltage, the addition of inductance does not in all cases reduce the intensity. The behaviour of the C III lines is very irregular, particularly at the lower inductances, and the enhancement of the intensity at about 32 kA, and at minimum inductance, is very pronounced. The carbon spectrum appears to be considerably more sensitive to the magnitude of the peak current than is the aluminium spectrum. The results for all the lines show a remarkable sensitivity to the direction of the current flow in the spark. A.

535.331

7827. Relative "f" values of Ca I. K. H. Olsen, P. M. Routly and R. B. King. *Stellar Atmospheres Conference* [*Indiana*] 46. See Abstr. 7656 (1955).

A graphite electric furnace of King type is used to obtain experimentally relative "f" values for lines of astrophysical interest in the spectrum of Ca vapour. Thus far, all lines of Ca I listed in the Revised Multiplet Table in the region 2900–3000 Å have been measured; and work is being continued to cover the region 3500–7000 Å. D. R. BARBER

535.331

7828. Absolute "f" values of Cr I and Cu I. M. H. Davis, P. M. Routly and R. B. King. *Stellar Atmospheres Conference* [*Indiana*] 47–9. See Abstr. 7656 (1955).

Using an atomic-beam apparatus, absolute "f" values of the six strongest ground-state lines of Cr I have been obtained. In addition, a check determination was made of the 3274 and 3247 Å lines of Cu I. Work continues on the strongest ground-state lines of Fe I. D. R. BARBER

535.331 : 523.872

The empirical determination of line strengths from stellar emission lines. *See Abstr.* 7655

535.333

7829. Relative transition probabilities of the violet CN bands. A. L. Floyd and R. B. King. *Stellar Atmospheres Conference* [*Indiana*] 44–5. See Abstr. 7656 (1955).

Furnace emission spectrograms obtained with a 1-metre concave grating spectrograph (dispersion, 16·8 Å/mm) have been used to measure bands in the $\Delta v = 0$, $+1$ and -1 sequences of the $B^2\Sigma - X^2\Sigma$ electronic system of CN. Values of the vibrational transition probabilities, $R^2_{v'v''}$, for the $B^2\Sigma - X^2\Sigma$ violet bands, derived from relative intensities in the heads of 13 bands are tabulated; and compared with two independent sets of theoretical data. D. R. BARBER

535.333

7830. The visible emission spectrum of Se_2. V. Lee-lavathi and P. Tiruvenganna Rao. *Indian J. Phys.*, **29**, *No.* 1, 1–10 (*Jan.*, 1955).

The emission spectrum of Se_2 as excited in a h.f. discharge, was photographed on a three-prism glass Littrow spectrograph having a dispersion of 7 Å/mm at λ4000. A new system has been detected in the region $\lambda\lambda$5900–6500 in addition to the one reported by Rosen and Montfort in the region $\lambda\lambda$5900–6800. A vibrational analysis of the new system has shown that the approximate values of ω'_e and ω''_e are 270 and 327 cm^{-1}. The system of Rosen and Montfort is also extended to include some more additional bands. The electronic states in Se_2 are discussed in relation to those of O_2, S_2 and Te_2. A.

535.333

7831. The band spectra of thallium iodide and fluoride. J. V. Ramana Rao and P. Tiruvenganna Rao. *Indian J. Phys.*, **29**, *No.* 1, 20–6 (*Jan.*, 1955).

The band spectra of TlI and TlF are reinvestigated in emission in a high-frequency discharge under higher dispersion than that employed previously. The analysis of the main system of TlI proposed by P. T. Rao and K. R. Rao has been confirmed. Using the more accurate data obtained in the present work, the following constants have been deduced: $\nu_e = 26362{\cdot}4$, $\omega'_e = 93{\cdot}7$, $x'_e\omega'_e = 0{\cdot}107$, $\omega''_e = 123{\cdot}2$, $x''_e\omega''_e = 0{\cdot}088$. In each one of these halides a new system has been detected. A vibrational analysis has also been proposed for each, which shows that the lower state is the ground state of the molecule. A.

535.337

7832. The Fowler line 4686 Å of ionized helium in the homogeneous electric field. W. Steubing and R. Günther. *Ann. Phys.* [*Leipzig*] **15**, *No.* 7–8, 345–75 (1955) In German.

The Stark effect on the line was examined photographically with a prism spectrograph of dispersion 25 cm^{-1}/mm and fields of 50–100 kV/cm. Calculations were made of the expected line splitting, having regard to the fine structure. The measured values for the components polarized parallel to the field agreed with the calculated values, but errors of measurement were too great to permit a redetermination of e and h. From accepted values of the fundamental constants, $2ea/3hc = 6{\cdot}402\times10^{-7}$ cm^{-1}/(volt/metre), while the experiments gave $6{\cdot}393\times10^{-7}$.

S. T. HENDERSON

535.338.334

7833. Effects of electron collisions on the width of spectral lines. H. Margenau and B. Kivel. *Phys. Rev.*, **98**, *No.* 6, 1822–4 (*June* 15, 1955).

The conditions under which the charges of a plasma take on particle characteristics and can be treated by classical mechanics are stated in terms of the half-width of the thermodynamic wave packet. A simple derivation is given for the quantity γ_U defined in a previous paper [Abstr. 5311 (1955)] (the line width resulting in the absence of degeneracy), which shows the formula there developed to be correct for large γ_U; this removes the earlier restrictions. A.

535.338.4

7834. Rotational analysis of the tantalum oxide bands. D. PREMASWARUP. Letter in *Nature [London]* **175**, 1003 (*June* 4, 1955).

The following constants (cm^{-1}) have been determined:

State	T_0	B_0
$^2\Sigma$	26679	0·3205
$^2\Pi$	23348	0·3156
$^2\Sigma$	0	0·3434

The value of r_0'' is 1·827 Å. R. F. BARROW

535.34.07

7835. New technique for high resolution microwave spectroscopy. R. H. ROMER AND R. H. DICKE. *Phys. Rev.*, **99**, *No.* 2, 532–6 (*July* 15, 1955).

An experiment is described in which microwave resonance lines have been obtained having widths substantially less than the normal Doppler width. The line shape obtained depends on the properties of a radiating gas when contained in a cavity in the form of a pillbox, of diameter large compared to height. Collisions of molecules with the walls take place in such a manner that the collisions narrow the line instead of broadening it. The 1·25 cm inversion transition in ammonia was observed, and lines one-quarter the normal Doppler width of 73 kc/s obtained; further narrowing appears feasible. The line shapes and widths are in good agreement with the calculations. A.

535.34.07

7836. A rapid recording absorption spectrophotometer. G. THEWS AND D. LÜBBERS. *Z. angew. Phys.*, **7**, *No.* 7, 325–31 (1955) In German.

Possible designs are reviewed. A beam from a double monochromator is divided into two, one through the solvent is chopped at 450 c/s and the other through the specimen is chopped at 1800 c/s. Both beams fall on one photomultiplier and the two frequencies are amplified by separate tuned amplifiers, the rectified outputs going to two fast (0·05 sec) mirror galvanometers. Beams from these fall on to a photorecorder. The instrument is being used for research on the progress of oxygen reactions of animal cells. G. F. LOTHIAN

535.34.07 : 536.48

7837. An optical absorption cell for use at low temperatures. V. ROBERTS. *J. sci. Instrum.*, **32**, *No.* 8, 294–6 (*Aug.*, 1955).

A transmission type cell designed for making optical and electrical measurements on solid specimens, but which could be adapted for liquids or gases, is described. The specimen is immersed in helium gas, which provides the thermal connection between it and the cooling liquid, and can be kept at a temperature within 1°K of that of the cooling bath between about 330 and 4·2°K. Operating times of over seventeen hours and one hour per filling of liquid hydrogen and liquid helium respectively are obtained. A simple mechanism enables the cooled specimen to be moved into and out of the radiation beam. A.

535.342

7838. Observations on the analysis of absorption curves. F. BERENCZ. *Acta phys. Hungar.*, **4**, *No.* 4, 317–25 (1955) In German.

To test the method of C. Doetsch [*Z. Phys.*, **49**, 705 (1928)] for analysing an unresolved spectrum supposed to consist of Gaussian-shaped bands, a portion of iron arc spectrum photographed at a resolving power of 20000 is so analysed and the result compared with a photograph at a resolving power of 200000. The method is found good for determining the number and the wavelengths of the lines. G. F. LOTHIAN

535.343

7839. The continuous atomic absorption cross sections for neutral atomic systems. G. V. MARR. Note in *Proc. Phys. Soc. A*, **68**, *Pt* 6, 544–6 (*June*, 1955).

Measured and calculated absorption cross-sections (σ) for elements with outer shell configurations s, s^2, s^2p and s^2p^6 are collected and plotted against atomic number (Z). For each configuration except the last σ shows a minimum near $Z = 20$. G. F. LOTHIAN

535.343

7840. Absorption cross section of helium and argon in the extreme ultraviolet. PO LEE AND G. L. WEISSLER. *Phys. Rev.*, **99**, *No.* 2, 540–2 (*July* 15, 1955).

The absorption of radiation of wavelength between 240 and 1000 Å in helium and argon was measured photometrically in a grazing incidence vacuum spectrograph. For helium a sharp absorption edge was observed at 504·3 Å. Near this edge the photoionization cross-section at 495·7 Å was found to be $6{\cdot}95 \times 10^{-18}$ cm^2. The variation of the cross-section as a function of the wavelength was in agreement with the computed curves by Wheeler and Vinti within the experimental error limit. For argon three absorption edges exist at 786·8, 778·0 and 424·0 Å corresponding to the M_3, M_2 and M_1 edges respectively. Possible autoionization phenomena between the M_2 and M_3 edges were observed. The cross-section at the M_2 edge was found to be $3{\cdot}5 \times 10^{-17}$ cm^2 which is comparable with the value computed by Dalgarno. A.

535.343

7841. Absorption spectrum of nitrogen in the region from 1075 to 1650 A. Y. TANAKA. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 663–4 (*Aug.*, 1955).

Using the argon continuum as a background, the absorption spectrum of N_2 was reinvestigated in the region between 1075 and 1650 Å. None of the absorption in this region reported by Weissler was observed. The Lyman–Birge–Hopfield absorption bands were extended up to $v' = 13$. Below 1130 Å, four bands were observed, three of which might be explained as the first three bands of transition $C^3\Pi_u \leftarrow X^1\Sigma_g^+$. A.

535.343

7842. Line breadths in the microwave magnetic resonance spectrum of oxygen. M. TINKHAM AND M. W. P. STRANDBERG. *Phys. Rev.*, **99**, *No.* 2, 537–9 (*July* 15, 1955).

The line-breadth parameters of a number of the X-band magnetic resonance spectrum of O_2 have been measured and interpreted with the aid of a previously reported theory of the spectrum. The results are that the M-dependence of the line width is negligible, and there is only a slight decrease in width with increasing K. A typical width (half-width at half-intensity) at 300°K is 2·2 (Mc/s)/mm Hg. At pressures up to 8 mm Hg, the line centres have been found to

shift less than 2% of the line width. The average temperature-dependence of the normalized line breadth parameter ($\Delta\nu/P$) is found to be $T^{\sim -0.75}$. This may be compared with the theoretical $T^{-0.627}$ and the $T^{-0.85}$ found by previous workers. O_2—N_2 collisions were found to be no less effective than O_2—O_2 collisions in producing broadening. A.

535.343

7843. Absorption in the Schumann ultraviolet. Study of the vapour of water and heavy water. A. JOHANNIN-GILLES. *J. Rech. Cent. Nat. Rech. Sci.*, **6**, 205–40 (*June*, 1955) In French.

Describes the construction of a vacuum spectrograph with a Fery fluorite prism, used for quantitative measurements of absorption; the plate is calibrated by exposure through calibrated gauzes. Measurements have been made giving curves of extinction coefficient (K) in the range $\lambda = 1500$–2300 Å for LiF, CaF_2 and BaF_2; also for SiO_2 (crystalline—R.H. and L.H., the former being more transparent—and fused, prepared in the presence of O_2, A, N_2, CO_2 and CO/CO_2, the last being least transparent) at temperature up to 900°C; K is greater at higher temperatures. LiF irradiated with X-rays shows a new band at 2000 Å. Vapours of H_2O and D_2O are measured at different temperatures and pressures; Beer's law does not hold; K, reduced to s.t.p. is smaller at higher pressure. Absorption peaks for $\lambda = 1600$–1700 Å are the same for H_2O and D_2O showing that they arise from electronic, not vibrational changes. H_2O shows a continuous absorption for 200–450 Å with a discontinuity at 370 Å (33·5 eV) together with some bands. Wave-mechanical theory of the water molecule is reviewed and the results discussed in the light of this; the discontinuity at 33·5 eV is attributed to ionization given in published calculations at 32 and 37 eV. 166 references. G. F. LOTHIAN

535.343

7844. Infrared spectrum of SOF_2. J. K. O'LOANE AND M. K. WILSON. *J. chem. Phys.*, **23**, *No.* 7, 1313–15 (*July*, 1955).

An investigation of the infrared spectrum of gaseous thionyl fluoride results in the following fundamental assignment:

$$\nu_1(a') = 1333\,\text{cm}^{-1},\ \nu_2(a') = 808\,\text{cm}^{-1},\ \nu_3(a') = 530\,\text{cm}^{-1}.$$
$$\nu_4(a') = (410)\,\text{cm}^{-1},\ \nu_5(a'') = 748\,\text{cm}^{-1},\ \nu_6(a'') = 390\,\text{cm}^{-1}.$$

Thermodynamic functions for SOF_2 are calculated with the usual assumptions. A.

535.343 : 535.375.5

7845. Infrared and Raman spectra of nitrogen trifluoride. E. L. PACE AND L. PIERCE. *J. chem. Phys.*, **23**, *No.* 7, 1248–50 (*July*, 1955).

The infrared spectrum of gaseous nitrogen trifluoride has been investigated with prism instruments in the range from 400 cm^{-1} to 3000 cm^{-1}. The Raman spectrum of liquid nitrogen trifluoride has been investigated in the range from 400 cm^{-1} to 2000 cm^{-1}. The fundamental frequency assignment made from the infrared data is $\nu_1(A_1) = 1031\,\text{cm}^{-1}$, $\nu_2(A_1) = 642\,\text{cm}^{-1}$, $\nu_3(E) = 907\,\text{cm}^{-1}$ and $\nu_4(E) = 497\,\text{cm}^{-1}$. The corresponding Raman shifts in the liquid are $\nu_1(A_1) = 1050\,\text{cm}^{-1}$, $\nu_2(A_1) = 667\,\text{cm}^{-1}$, $\nu_3(E) = 905\,\text{cm}^{-1}$ and $\nu_4(E) = 515\,\text{cm}^{-1}$. Differences from the results of previous investigators appear either in the assignment of the fundamental frequencies or in the interpretation of the overtone and combination bands in the infrared spectrum. The present results are considered more reliable because of (1) the added weight of an investigation of the Raman spectrum and (2) the use of a sample of known high purity. A.

535.343 : 539.132

7846. Microwave and radiofrequency spectroscopy. D. H. WHIFFEN. *Nature* [*London*] **176**, 18–20 (*July* 2, 1955).

Brief report of a three-day Faraday Society meeting in April, 1955.

535.343

7847. Infrared spectra of liquid anhydrous hydrogen fluoride, liquid sulfur dioxide, and hydrogen fluoride–sulfur dioxide solutions. R. H. MAYBURY, S. GORDON AND J. J. KATZ. *J. chem. Phys.*, **23**, *No.* 7, 1277–81 (*July*, 1955).

The infrared spectra of anhydrous liquid hydrogen fluoride, anhydrous liquid sulphur dioxide and mixtures of the two have been measured in the region from 1 to 25 μ. A value for the extinction coefficient for the polymer peak in the region higher than previously reported has been found, reflecting the existence of a greater proportion of higher hydrogen fluoride polymers in the liquid as compared with the gas. A study of the change in the spectra of solutions of varying concentration of anhydrous liquid hydrogen fluoride in anhydrous liquid sulphur dioxide has been made and its possible relation to the structure of the polymers in liquid hydrogen fluoride examined. The possible applicability of obtaining spectra of protein dissolved in anhydrous liquid mixtures of hydrogen fluoride and sulphur dioxide has been explored and a spectrum of silk fibroin in this solvent is presented. A.

535.343

7848. Infrared absorption of silicon near the lattice edge. G. G. MACFARLANE AND V. ROBERTS. Letter in *Phys. Rev.*, **98**, *No.* 6, 1865–6 (*June* 15, 1955).

Accurate measurements of K with temperature down to 20°K and with wavelengths near the edge. As with germanium the results are well fitted by a two-term theoretical equation based on a theory of indirect transitions. The energy gap E_G varies quadratically with temperature at low temperatures. The results are used to estimate the position of the conduction band minima and to correlate the values of E_G with the data of Morin and Maita on intrinsic carrier concentration. C. A. HOGARTH

535.343 : 537.311.33

7849. Optical properties of plastically deformed germanium. H. G. LIPSON, E. BURSTEIN AND P. L. SMITH. *Phys. Rev.*, **99**, *No.* 2, 444–5 (*July* 15, 1955).

N-type germanium specimens of 1 ohm-cm resistivity were plastically deformed from 3 to 15% at about 700°C. The more strongly deformed specimens were found to be converted to *p*-type. All of the deformed specimens exhibited a shift in the intrinsic absorption edge as well as an extended tail. Those

samples which were converted to *p*-type also exhibit the characteristic absorption bands due to free holes. These results differ from those obtained for neutron-bombarded germanium which exhibits no shift of the absorption band and a tail of somewhat different character from that found in the plastically deformed material. A.

535.343 : 537.312.5

7850. Optical properties of indium-doped silicon. R. NEWMAN. *Phys. Rev.*, **99**, *No.* 2, 465–7 (*July* 15, 1955).

Absorption and photoconduction have been studied in indium-doped silicon at low temperatures. The optical properties indicate a level at about that obtained from thermal-resistivity measurements, i.e. 0·16 eV. Sharp absorption lines are observed at 20°K which broaden and essentially disappear by 77°K. A.

535.343

7851. Perturbation of the near ultraviolet absorption spectrum of benzene vapour by foreign gases compressed up to 1000 kg/cm². B. OKSENGORN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 24, 2300–2 (*June* 13, 1955) In French.

Bands in the range 2300–2600 Å progressively lose their structure, are broadened and are shifted to the red by amounts proportional to the pressure of A or N_2 up to 6 Å. N_2 has the greater effect.

G. F. LOTHIAN

535.343

7852. Infrared spectra of gaseous and solid hydrazoic acid and deutero-hydrazoic acid: the thermodynamic properties of HN_3. D. A. DOWS AND G. C. PIMENTEL. *J. chem. Phys.*, **23**, *No.* 7, 1258–63 (*July*, 1955).

Infrared studies of HN_3 and DN_3 in the gas and solid phases and of HN_3 in CCl_4 solutions are presented. The two low-frequency skeletal bending modes are identified, permitting calculation of the thermodynamic properties of hydrazoic acid. Hydrogen bonding of HN_3 and DN_3 in the solid state is indicated by frequency shifts of the NH and ND stretching motions (216 and 151 cm^{-1}, respectively). No evidence of hydrogen bonding was observed in solutions of HN_3 in CCl_4 at concentrations up to 0·3 M. An irreversible phase transition is observed on warming solid hydrazoic acid above about 120°K. A.

535.343

7853. Infrared absorption spectrum of deuterated polyvinyl alcohol film. H. TADOKORO, S. SEKI AND I. NITTA. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1351–2 (*July*, 1955).

The spectra before and deuteration in D_2O vapour are plotted and the assignments of the bands discussed. G. F. LOTHIAN

535.343

7854. Microwave spectrum of cyclopentanone. J. H. BURKHALTER. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1172 (*June*, 1955).

Accurate measurement and identification of 10 microwave transitions give I_a 76·33354, I_b 150·7908 and I_c 209·7114 atomic mass units × (ångströms)². D. H. WHIFFEN

535.343

7855. Methyl alcohol. I. Microwave spectrum. P. VENKATESWARLU, H. D. EDWARDS AND W. GORDY. *J. chem. Phys.*, **23**, *No.* 7, 1195–9 (*July*, 1955).

The $J = 0 \rightarrow 1$, $K = 0 \rightarrow 0$ rotational lines of methyl alcohol have been observed and identified with the Stark effect for $C^{12}H_3O^{16}H$, $C^{13}H_3O^{16}H$, $C^{12}H_3O^{16}D$, $C^{13}H_3O^{16}D$, $C^{12}D_3O^{16}H$ and $C^{12}D_3O^{16}D$. These lines are obtained not only for the molecules in the ground state but also for those in the first two torsional excited states, $n = 1$ and $n = 2$. All these lines except those of the $C^{12}D_3O^{16}D$ were observed to be doublets, the doublet separation being different for different molecules. Some further experimental data on $C^{12}D_3O^{16}H$, $C^{12}H_3O^{16}D$ and $C^{13}H_3O^{16}H$ are included. A.

535.343

7856. Microwave spectrum of propiolic aldehyde. J. A. HOWE AND J. H. GOLDSTEIN. *J. chem. Phys.*, **23**, *No.* 7, 1223–5 (*July*, 1955).

This was studied in the 18–37 kMc/s region. Analysis of the ground state spectrum provides the following rotational constants: $b = 4826{\cdot}31 \pm 0{\cdot}03$ Mc/s; $c = 4499{\cdot}75 \pm 0{\cdot}03$ Mc/s; and $\delta = 0{\cdot}00594 \pm 0{\cdot}0030$ Mc/s, consistent with a planar model. Strong vibrational satellites were observed and fitted, and approximate values of the two lowest vibrational frequencies were found from intensity ratios to be roughly 150 cm^{-1} and 230 cm^{-1}. The dipole moment of the ground vibrational state is $2{\cdot}46 \pm 0{\cdot}04D$, as determined from quantitative Stark effect studies. A.

535.371

7857. Sensitized luminescence of zinc sulfide phosphors activated with copper and manganese. S. SHIONOYA. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1173–4 (*June*, 1955).

535.371

7858. Luminescence of crystals at low temperatures. VIII. $T \rightarrow S$ transitions of hexachlorobenzene at 90°K. A. ZMERLI AND P. PESTEIL. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 23, 2217–19 (*June* 6, 1955) In French.

For Pt VII, see Abstr. 6937 (1955).

535.371

7859. Fluorescent centres in uranium-activated sodium fluoride. W. A. RUNCIMAN. Letter in *Nature* [*London*] **175**, 1082 (*June* 18, 1955).

Introduction of uranium into sodium fluoride by fusion in air produces a bright yellow-green fluorescence for 3650 Å excitation. This is ascribed to UO_6 groups, the uranium replacing sodium and the six oxygen atoms replacing the surrounding fluorine atoms. Divalent metal impurities enhance the fluorescence, the process being assumed to involve charge neutralization and pairing of uranium and calcium ions. G. F. J. GARLICK

535.371 : 537.312.5

7860. Infrared stimulation and quenching of photoconductivity in luminescent powders. H. KALLMANN, B. KRAMER AND A. PERLMUTTER. *Phys. Rev.*, **99**, *No.* 2, 391–400 (*July* 15, 1955).

A.C. measurements of impedance changes in (ZnCd)S fluorescent powders upon addition of infrared radiation (*a*) simultaneously with the exciting

ultraviolet and (*b*) various periods after excitation by ultraviolet- or γ-radiation are described. A decrease (quenching) of conductivity is always observed in the steady state (*a*), but in case (*b*) a strong increase (stimulation) is often observed. The simultaneous quenching shows two maxima, one in the 7500 Å region, the other about 12500 Å, but the stimulation decreases monotonically with increasing wavelengths. These two effects (quenching and stimulation) are superimposed; quenching can most easily be observed at relatively high conduction electron density, while stimulation is most easily observed long after excitation has ceased. The conductivity stimulation can be observed with most (ZnCd)S phosphors many days after cessation of excitation; thus these materials act as storage phosphors in which, however, the storage properties are observed by conductivity stimulation. Their light stimulability is often small. A specially activated Fonda-type storage phosphor with a very high light stimulability, however, shows only small conductivity stimulation. An explanation of this behaviour and the wavelength-dependence of the stimulation and quenching in terms of the action of infrared irradiation on trapped and valence-band electrons is given. A.

535.375.5

7861. Study of the Raman scattering band characteristic of the vibration of the carbonyl group of ketones in the region 1700 cm^{-1}. E. Gray and M.-M. Bottreau. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 22, 2134–6 (*June* 1, 1955) In French.

The Raman spectra of the following ketones have been measured in the 1700 cm^{-1} region: cyclopentanone, acetophenone, cyclohexanone, meta-methylcyclohexanone, di-isobutylketone. Bands characteristic of both the keto and enol forms have been observed. G. I. W. LLEWELYN

535.375.5

7862. Raman spectra of thionyl fluoride and sulfuryl fluoride. P. Bender and J. M. Wood, Jr. *J. chem. Phys.*, **23,** *No.* 7, 1316–17 (*July*, 1955).

The Raman spectra of liquid and gaseous sulphuryl fluoride (SO_2F_2) and of liquid thionyl fluoride (SOF_2) have been investigated and depolization factors measured for the stronger lines scattered by the liquids. For SO_2F_2 the Raman shift due to the infrared inactive torsional mode has been found to be 338 cm^{-1}, and other previous assignments based on the infrared spectrum have been confirmed. For SOF_2, the symmetric SF_2 stretch occurs at a higher frequency than the asymmetric stretch; the reverse is true for SO_2F_2. The symmetric SF_2 bending mode has escaped detection for both compounds. A.

535.376

7863. On the mechanism of organic electroluminescence. A. Bernanose. *J. Chim. phys.*, **52,** *No.* 5, 396–400 (*May*, 1955) In French.

Two mechanisms for excitation of luminescence in organic molecules are proposed, direct excitation of the molecules and excitation of molecules by impact of electrons accelerated by the applied field as in inorganic phosphors. The theory predicts the order of magnitude of the effect and also the relation between emission and applied field. G. F. J. GARLICK

535.376

7864. Effect of high resonance fields on electroluminescent condensers. A. Luyckz. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 23, 2219–21 (*June* 6, 1955) In French.

An electroluminescent cell forming the capacity of a tuned circuit with variable inductor shows a variation of light emission with inductance which reaches a maximum at resonance. An increase in intensity of 30 times can occur at resonance relative to non-resonance emission. G. F. J. GARLICK

535.376

7865. Alternative explanation of the Waymouth–Bitter experiment. L. Burns. Letter in *Phys. Rev.*, **98,** *No.* 6, 1863 (*June* 15, 1955).

See Abstr. 10076 (1954).

535.39

7866. Determination of the indices and the thickness of stratified monomolecular layers of haemin. D. Malé and R. Rinaldi. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 2, 2130–2 (*June* 1, 1955) In French.

In a previous work [Abstr. 3644 (1955)] the optical properties of films of haemin made of between 1 and 12 monomolecular layers were described. The present work extends the measurements to cover films of up to 40 monolayers. The films were formed on water, removed by means of a wire ring, and deposited on to a glass slide. The layers had a mean index of refraction of 1·7, and of extinction 0·35. The thickness of a monolayer was found to be 20 Å. D. G. AVERY

535.393

7867. The effect of aluminium purity on the reflectivity of evaporated front surface mirrors. L. Holland and B. J. Williams. Note in *J. sci. Instrum.*, **32,** *No.* 7, 287 (*July*, 1955).

After ageing, reflectivities of 99 and 99·99% purity Al are 86 and 89%. G. F. LOTHIAN

535.412 : 535.345.6

7868. A theory of interference filters. A. Hermansen. *K. Danske Vidensk. Selsk., mat-fys. Medd.*, **29,** *Paper* 13, 96 *pp.* (1955).

Fresnel's equations are applied to the computation of the optical properties of interference filters. In particular the filters are studied which have three and four silver layers. In addition the case of dielectric multilayers is worked out as is also the case of oblique incidence. Optical properties such as reflectivity, transmission and phase changes both at reflection and transmission are computed, provided the refractive index and the thickness of the separate layers is known. S. TOLANSKY

535.412 : 535.345.6

7869. Coefficient of transmission at the maximum of an interference filter. D. Lagarde and R. Dupeyrat. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 20, 1980–2 (*May* 16, 1955) In French.

A computation is made of the theoretical value of the coefficient of transmission at the maximum of a symmetrical filter deposited upon glass. This value is independent of the number of double layers and of the indices of the layers. It is obtained by the classical Fresnel formula. Enhancement with anti-reflection layers enables an increase in transmission to be secured, of the order of 5%. S. TOLANSKY

535.417

7870. A method for the evaluation of line displacement when using the Tolansky method with incident light. H. KIMMEL. *Z. angew. Phys.*, **7**, *No.* 6, 294–5 (1955) In German.

In the interferometric method of measuring thin films using multiple-beam interferometry it is necessary to use incident illumination. This excludes the use of several spectrum lines simultaneously. It is advantageous to have bright fringes on a dark background instead of the normal dark fringes on a bright background. This can be achieved by introducing an aperture correctly in the focal plane of the microscope objective. The first reflected beam can be cut out and then the interference pattern changes in character and becomes similar to the pattern in transmission.

S. TOLANSKY

535.417

7871. Direct unambiguous display: a new method with the Fabry–Perot interferometer for emission and absorption. J. H. JAFFE, D. H. RANK AND T. A. WIGGINS. Letter in *Bull. Res. Coun. Israel*, **4**, *No.* 4, 398–9 (*March*, 1955).

By gradually changing the air pressure between the plates the spectrum is made to traverse the axis where it is recorded by a photocell. A monochromator in series whose transmission wavelength is changed in sympathy prevents overlap of orders with its consequent ambiguity. G. F. LOTHIAN

535.417

7872. Calculation of Fabry–Perot étalons and compound étalons. D. LAGARDE AND R. DUPEYRAT. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2062–4 (*May* 23, 1955) In French.

The matrix method for the calculation of the transmission of thin films [Abstr. 7869 (1955)] is applied to Fabry–Perot étalons and compound étalons having dielectric films on their surfaces. Some general conclusions concerning the film properties and maximum transmission are derived. R. W. FISH

535.417

7873. Interferometer quality and its relation to photographic resolving power. N. MURCOTT AND H. S. GOTTFRIED. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 644–6 (*Aug.*, 1955).

The concept of interferometer quality is discussed and the idea extended to cover non-symmetrical interferograms. Attempts to correlate this function with low-contrast photographic resolving power are described. A.

535.421

7874. A contribution to diffraction by gratings and by a slit. W. MESSERSCHMIDT. *Optik*, **12**, *No.* 7, 297–315 (1955) In German.

The diffraction pattern of a grating can be determined by consideration of the effect of the grating as a whole or by considering the individual slit and superimposing their individual patterns. The latter method is used and the patterns given by various forms of amplitude and phase gratings derived. Recordings illustrating the patterns are included.

R. W. FISH

535.421

7875. Envelope displacement of reflecting echelon fringes. J. BLACKIE AND T. A. LITTLEFIELD. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 658–62 (*Aug.*, 1955).

The displacement of reflecting echelon fringes due to the envelope curve has been investigated theoretically. It is shown that, over the range in which measurements are likely to be made, envelope displacement is proportional to the distance from the single-order position, and experimental data confirming this have been obtained. The observed displacements are, however, about three times as great as those calculated, and the discrepancy is attributed to the error of figure of the echelon surface. Graphs have been drawn enabling the wavelength error to be rapidly assessed for a given source and echelon. A.

535.435 : 534.23

Sound absorption in liquids in relation to light scattering data. *See Abstr.* 7784

535.435 : 541.64

7876. Contribution to the study of the scattering of light by solutions of anisotropic macromolecules. P. HORN. *Ann. Phys.* [*Paris*], **10**, 386–434 (*May–June*, 1955) In French.

Theory is developed for the intensity distribution of the polarized components of the scattered light from anisotropic rods and random chains; the anisotropy is expressed as a function (δ) of the two principal polarizabilities. Photoelectric measurements are made at $\lambda = 4358$ Å. Results indicate for rods of tobacco mosaic virus $\delta^2 = 0{\cdot}09$; the positive root is taken as indicated by the sign of the flow birefringence. The rod length is found 2300 ± 200 Å. Similar measurements on thymonucleic acid, whose structure is in doubt, suggest a rod form, i.e. a very rigid chain. The theory for random chains indicates that the intensity of the H_v component should be independent of the molecular weight; this is confirmed by measurements on solutions of nitrocellulose. G. F. LOTHIAN

535.44

7877. Study of Rayleigh scattering by quartz. J. CHAPELLE AND L. TAUREL. *J. Chim. phys.*, **52**, *No.* 4, 307–13 (*April*, 1955) In French.

Measurements at temperatures $T = 20$–200°C show large variations but after several temperature cycles results are repeatable and intensity plotted against T gives straight lines; intensities of different polarizations with different incident polarizations are compared. If it is assumed that the portion of the scattered light varying linearly with T is due to thermal waves then it is found that the measured ratios are in accord with theory. Observations and theory are then used to calculate incident intensity in arbitrary units. This value combined with a measurement of scatter of $\lambda = 4358$ Å by benzene is used to calculate a value of 25×10^{-6} for the Rayleigh ratio of benzene.

G. F. LOTHIAN

535.51

7878. The quartz prism spectrograph as analyser for polarized light. H. C. WOLF AND D. GRIESSBACH. Note in *Naturwissenschaften*, **42**, *No.* 8, 206–7 (1955) In German.

When the collimator lens of a quartz prism spectrograph is made from crystalline quartz, it rotates the plane of polarization of incident light which is parallel

to the axis. Since the quartz has dispersion the transmission of the spectrograph is a function of wavelength. An experimental arrangement making use of this property is described. R. W. FISH

535.551

7879. Note on the mechanical and optical anisotropy of materials submitted to constraint. A. KAMMERER. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 25, 2374–6 (*June* 20, 1955) In French.

When a material is strained an expression can be derived for the stress as a function of strain: this expression neglects the influence of viscosity and includes terms of degree higher than unity. By limiting the latter to second degree terms, evidence of a mechanical anisotropy in agreement with the optical anisotropy (photoelasticity) of transparent materials is obtained. H. G. JERRARD

535.56

7880. A simple method for measuring and demonstrating rotatory dispersion. D. GRIESSBACH AND H. C. WOLF. Note in *Naturwissenschaften*, **42,** *No.* 8, 207 (1955) In German.

Uses two Nicols and a quartz spectrograph to cover the range 2500–6000 Å. G. F. LOTHIAN

535.568.1

7881. Stroboscope polarimeter. G. F. LANDEGREN. *Rev. sci. Instrum.*, **26,** *No.* 6, 578–9 (*June*, 1955).

Light, after passing through a continuously rotating Polaroid disk, carrying a degree scale, then goes through a stationary Polaroid disk and is incident as sinusoidally modulated light upon a phototube, causing it to produce a signal (of audio-frequency twice that of the frequency of rotation) which is then passed through an audio amplifier and fed to a stroboscope directed on the rotating disk, which thereby flashes in synchronism with the signal and hence also with the rotation of the disk. By adjusting the angular position of the stationary disk, the zero mark on the rotating disk is made to appear to coincide with a stationary fiducial mark. When an optically active sample is interposed between the polaroid disks, there is a phase shift in the modulation of the light which causes a reading, as observed in stroboscopic light, on the rotating disk equal to the angular rotation produced by the sample. A.

535.7

Physiological optics. Vision. *See under* "Medical science. Human physiology." Decimal classification 612.84

535.8

7882. Two-dimensional coding of optical images. W. BROUWER AND A. C. S. VAN HEEL. Letter in *Optica Acta*, **2,** *No.* 1, 49–50 (*April* 1955).

The use of transparent fibres for the transfer of optical images allows the coding and de-coding of the image by arranging the fibres in an irregular manner. A simple method of manufacture is illustrated.

R. W. FISH

535.81

7883. A new schlieren diaphragm. E. ROEPER. *Optik*, **12,** *No.* 6, 283–4 (1955) In German.

Some practical details of a new double slit are given and its use in schlieren work briefly described.

R. W. FISH

535.81

7884. A criterion for achromats. F. I. HAVLIČEK. Letter in *Bull. sci. Cons. Acad. Yougoslavie*, **2,** *No.* 2, 42–3 (*April*, 1955) In German.

A graph is given connecting the focal length of an achromat and its relative aperture, for either terrestrial or astronomical standards of achromatism. These standards are based upon the wavefront errors for a number of spectral lines, and the method of calculation is briefly described. R. W. FISH

535.824.1

7885. A triplet eyepiece for a microscope. A. BIOT. *Ann. Soc. Sci. Bruxelles I*, **69,** *No.* 1, 24–6 (1955) In French.

The eyepiece described has a large eye separation, and is derived from a Huyghenian eyepiece by placing a negative lens in the focal plane of the eyelens. The eyelens itself is made a doublet to obtain adequate control of aberrations. R. W. FISH

535.89 : 621.373.43

7886. Electronic double flash generator for monocular and binocular stimulation. F. H. IRELAND. *Rev. sci. Instrum.*, **26,** *No.* 7, 718–19 (*July*, 1955).

An electronic generator produces double flashes of intense white light, both flashes appearing either in the same lamp or each in a separate lamp as desired. Intervals between flashes can be varied from 2 to 600 msec. Stimulus pairs are initiated either automatically or by manual control. A.

HEAT 536

536.022

7887. Upon the quick evaluation of thermal conductivity. C. CODEGONE. *Atti Accad. Sci. Torino I*, **89,** 99–100 (1954–55) In Italian.

It is shown that for many cases, the rather complex function expressing the conductivity of a sample, derived by determining the law of temperature variation at the centre of the sample itself when the external temperature is abruptly altered, may be replaced by a simple approximate relation permitting easier solution. [See *Atti Accad. Sci. Torino I*, **88,** 16–20 (1953–54).] J. J. PHIPPS

536.2.01

7888. A comment on the communication of H. Wundt: "On a functional equation of heat conduction." M. HOSSZU. Note in *Z. angew. Math. Phys.*, **6,** *No.* 2, 143–5 (1955) In German.

See Abstr. 8220 (1954). It is suggested that the original solution was incorrect and that the only differentiable solution of the functional equation $2f\{(x-y)/(\ln x/y)\} = f(x) + f(y)$ is $f(x) =$ constant.

E. H. DOCK

536.21 : 548.7

7889. Thermal conduction in artificial sapphire crystals at low temperatures. I. Nearly perfect crystals. R. BERMAN, E. L. FOSTER AND J. M. ZIMAN. *Proc. Roy. Soc. A*, **231,** 130–44 (*July* 19, 1955).

In order to obtain a detailed verification of the theory of thermal conduction in dielectric crystals,

measurements have been made on a number of artificial sapphire crystals between 2 and 100°K. In the region of the maximum there are variations in conductivity between crystals from different sources. The highest conductivities measured are about 140 W/cm.deg., which suggests that estimates of several hundred watts for the maxima of ideal sapphire crystals are not unreasonable. At sufficiently low temperatures the conductivity of a very perfect, long crystal with rough surfaces is observed, in agreement with Casimir's theory of boundary scattering, to be proportional to T^3 and to the radius; the phonon mean free path is then nearly equal to the crystal diameter. Imperfect crystals show some anomalous effects. The extension of Casimir's theory to apply to short specimens has been verified. Perfect crystals with smooth surfaces exhibit some specular reflection of phonons; a statistical description of the surface is proposed which leads to the observed variation of this effect with temperature and is compatible with the results of interferometric examination of the surface.

A.

536.212.2

7890. The thermal conductivity of nickel on both sides of the Curie point. L. HUGON AND J. JAFFRAY. *Ann. Phys.* [*Paris*] **10**, 377–85 (*May–June*, 1955) In French.

The probable existence of a discontinuity or a rapid variation in the thermal diffusivity at the Curie point is shown by experiment. The thermal conductivity λ, derived from the Lorentz law, is shown to be continuous up to the Curie point at which it presents a minimum. The variation of the Lorentz number with temperature is given. H. C. COLE

536.212.2 : 537.311.31 : 536.48

7891. The thermal and electrical conductivity of palladium at low temperatures. W. R. G. KEMP, P. G. KLEMENS, A. K. SREEDHAR AND G. K. WHITE. Letter in *Phil. Mag.*, **46**, 811–14 (*July*, 1955).

Measurements of thermal conductivity are made at temperatures from 2 to 160°K. Below 40° there is a marked divergence between results obtained with different specimens which had been pre-stressed and annealed to a different amount. The electrical resistivity of a specimen is found to be a linear function of $T^{3\cdot2}$ at low temperatures. R. EISENSCHITZ

536.25

7892. On the natural convection of heat from a wire. P. VERNOTTE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2057–9 (*May* 23, 1955) In French.

The usual equation for thermal equilibrium of an electrically heated horizontal wire in a convective medium is considered. It is shown that by varying the length of the wire the manner in which the convection depends on the temperature or wire diameter may be found, but that the absolute value of the convection coefficient cannot be obtained in this way. It is suggested that to find the latter it is necessary to have a wire at a uniform temperature throughout, the end supports being at the same temperature as the wire.

F. E. HOARE

536.33 : 534.213

Mean free path in problems of acoustic and thermal radiation. *See Abstr.* 7764

536.33.08

7893. Metal-resistance bolometers at low temperatures. K. BISCHOFF, E. JUSTI, M. KOHLER AND G. LAUTZ. *Z. Naturforsch.*, **10a**, *No.* 5, 401–12 (1955) In German.

The variation in sensitivity of resistance-bolometers as a function of temperature is discussed. A considerable increase in sensitivity is to be expected when the operating temperature T is within the region $\theta_D/3 > T > \theta_D/10$, where θ_D is the Debye temperature and a rough calculation for Ni foil shows that a 10-fold increase compared with room-temperature is possible. Starting from the heat conduction equation, expressions are derived for the constant- and modulated-radiation sensitivities of freely-supported metal foils *in vacuo* and it is shown that there is an optimum foil-length $D_{opt} = \sqrt{(\pi\lambda/2\rho cf)}$, where λ, ρ and c are the thermal conductivity, density and specific heat of the foil material respectively, corresponding to the modulation frequency f. One Pd foil and four different Ni foil bolometers were tested experimentally at various temperatures down to 55°K. The data are tabulated and constructional details given. The agreement between the theoretical and measured sensitivities is shown graphically and discussed.

S. WEINTROUB

536.41 : 621.317.79

7894. Electronic vacuum dilatometer. M. E. DOOLEY AND D. F. ATKINS. *Rev. sci. Instrum.*, **26**, *No.* 6, 568–71 (*June*, 1955).

The dilatometer is based on the use of a linear variable differential transformer. Expansion or contraction of the specimen moves a silica pusher-rod which, in turn, changes the position of the core of the linear transformer. The output of the transformer is directly proportional to the displacement of this core. The output is amplified, rectified, and fed into the chart-moving circuit of a function-plotting potentiometer. The transformer is supplied by a 2000 c/s oscillator. By varying the input voltage to the transformer, magnification of the expansion curves can be increased or decreased as desired. The instrument has been used for about a year for the detection of solid-phase transformations in alloys. Several curves are reproduced to illustrate the performance of the instrument. A.

536.413 : 536.48

7895. On the thermal expansion of solids at low temperatures. T. H. K. BARRON. *Phil. Mag.*, **46**, 720–34 (*July*, 1955).

Following recent experiments in which Grüneisen's γ was observed to decrease at temperatures below $0{\cdot}3\,\Theta$, an investigation is made of the variation of γ with temperature according to the lattice dynamics of Born and von Kármán. γ is defined as a function of T, and a general analysis applicable to all lattices is used to derive the low and high temperature limits γ_0 and γ_∞. By expressing γ as a quotient of power series in T^{-1} it is shown that the main variation between these limits occurs at temperatures of the order of $0{\cdot}2\,\Theta$. Calculations are carried out for a cubic close packed lattice with central forces between nearest neighbours; it is found that $\gamma_\infty - \gamma_0 = 0{\cdot}3$, and that the behaviour of γ is qualitatively similar to that found experimentally in monatomic metals.

The amount of variation in γ is decreased when interaction between more distant neighbours is taken into account, and a model representing the heavier inert gas solids gives $\gamma \sim 3$ and $\gamma_\infty - \gamma_0 \sim 0{\cdot}15$. A.

536.421.1

7896. Melting curves of He^3, He^4, H_2, D_2, Ne, N_2, and O_2 up to 3500 kg/cm². R. L. MILLS AND E. R. GRILLY. *Phys. Rev.*, **99**, *No.* 2, 480–6 (*July* 15, 1955).

New and more accurate measurements were made on the melting pressure-temperature relationship of seven substances below 120°K and up to 3500 kg/cm². New regions were covered for He^3 and O_2. The blocked-capillary method was used. The data were fitted to the Simon-type equation, $P = a + bT^c$, with more success than to a quadratic, $P = A + BT + CT^2$. Rather straightforward shifts were obtained in the melting curves of the isotope pairs, He^3—He^4 and H_2—D_2. Superpressuring in the O_2 measurements was unusually great. A.

536.423.4

7897. Adsorption of potassium on quartz surfaces. H. WEGENER. *Z. Phys.*, **140**, *No.* 5, 465–72 (1955) In German.

Using the apparatus described in Abstr. 2234 (1955) the adsorption coefficient γ, i.e. the fraction of the atoms incident on a surface which stay on the surface for a time greater than 12×10^{-12} sec, is measured for *K* on quartz and it is found that $\gamma = 1$ for the range −180 to 21°C. S. WEINTROUB

536.423.4

7898. Efficiency of condensation nuclei (potassium on quartz). H. WEGENER. *Z. Phys.*, **140**, *No.* 5, 473–84 (1955) In German.

See preceding abstract. K vapour condenses on quartz in the form of small drops which occur again and again at the same points, the "condensation nuclei," on the surface. Most of the incident K atoms are first adsorbed on the quartz and then move over the surface to the drops. The dependence of the formation of the drops on the evaporation rate and on the nuclei is investigated theoretically and experimentally. It is shown that for a drop to form on a nucleus there is a minimum critical evaporation rate ν which must not be exceeded and that ν is not only dependent on the structural nature of the substrate but also on the presence of drops at neighbouring points. Any surface usually has sufficient irregularities to provide points at which the formation of drops may be favoured, but it is shown that two conditions must be fulfilled, namely, the diffusion coefficient of the atoms along the surface, and the work of formation, must be smaller at these than at other points on the surface.

S. WEINTROUB

536.424

7899. A contribution to the study of the influence of impurities on allotropical changes in cobalt. A. KOCHANOVSKÁ. Letter in *Czech. J. Phys.*, **5**, *No.* 2, 279–80 (*April*, 1955) In Russian.

536.424

7900. Optical observation of the first-order transition of barium titanate single crystal at the Curie point. A. NISHIOKA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 535–40 (*July*, 1955).

This first-order transition was observed optically at the Curie point of about 120°C by a polarizing microscope, and the domain boundary movement was cinematographically recorded. The crystal was so called *c*-plate, and the area and the thickness were about 0·1 mm² and 0·03 mm respectively. With increasing temperature, no change was observed up to the Curie point, but at about 120°C the domains begin to move rapidly and discontinuously and heterogeneous transformation of *c*-plate to *a*-plate occurs. Then discontinuous and rapid changes of *a*-plate to cubic phase occur, and the transition is finished. During this transition some interesting domain patterns were observed, caused by the penetration of two perpendicular domains. A.

536.424

7901. Thermal transition of transparency in ferroelectric single crystal of barium titanate. T. HORIE, K. KAWABE, M. TACHIKI AND S. SAWADA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 541–9 (*July*, 1955).

The ferroelectric single crystal of barium titanate exhibits a strong absorption in the u.v. region at any temperature including the three transition points. The threshold for the u.v. absorption shifts gradually towards longer wavelengths as the temperature rises, and the temperature coefficient is about one ångström per degree centigrade. In addition to this u.v. absorption, the crystal exhibits another absorption in the visible region. The intensity of natural light with wavelengths in the neighbourhood of 5000 Å transmitted through the crystal is measured by means of a multiple phototube. It shows quite steep and sudden changes near the transition temperatures, especially in thin crystals. Let $I(T)$, $I(O)$ and $I(R)$ be the intensity of transmitted light in the tetragonal, orthorhombic and rhombohedral phases respectively. Then the following relations can be drawn out of the various curves for the thermal transition of transparency. They are $I(O) \lesssim \frac{1}{2}I(T)$ and $I(R) \gtrsim \frac{1}{4}I(T)$. From calculations on optical paths through the adjacent domains in the orthorhombic phase, the former relation is derived. The same considerations in the rhombohedral phase lead to the latter. Furthermore for polarized light, the behaviour is partially different from that for natural light. In the present paper experimental results for the thermal transition of transparency for both natural and polarized light are interpreted from the standpoints of the theories of ferroelectric domains and crystal optics. A.

536.424 : 537.311.32

7902. On the transition point of chromium sesquioxide and its electrical conductivity at moderately elevated temperatures. J. ROCHE AND J. JAFFRAY. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 23, 2212–13 (*June* 6, 1955) In French.

Conductivity–temperature measurements on specimens of Cr_2O_3 give rectilinear plots of log conductivity against $1/T$ with a change of slope at 33°C, the temperature of a specific heat anomaly and a dilatation.

C. A. HOGARTH

536.44

7903. Critical isotherm and the equation of state of liquid-vapor systems. B. WIDOM AND O. K. RICE. *J. chem. Phys.*, **23**, *No.* 7, 1250–5 (*July*, 1955).

Pressure-volume-temperature data on xenon, carbon dioxide, and hydrogen are analysed. Special

attention is paid to the regions fairly close to, but not in the immediate neighbourhood of, the critical point. It is shown that in each case the critical isotherm is of the fourth degree, one degree higher than that of the co-existence curve, as is required by the theorem of Rice. However, the relation between the critical isotherm and the co-existence curve is determined by the almost constant value of $\partial^2 P/\partial T \partial \rho$ in the *PVT* region considered, and this is different from its value at the critical point. The critical isobar is also considered and it is shown that it is of the fourth degree near the critical point, but of lower degree further away. A general equation of state is deduced for the *PVT* region under discussion, and the implications of this equation of state with respect to the coexistence curve and the critical isotherm are considered. A.

536.46

7904. A similarity relation in thermal radiation of flames. C. CODEGONE. *Atti Accad. Sci. Torino I*, **89**, 64–5 (1954–55) In Italian.

This has been investigated for flames of different sizes, burning in identical conditions. It permits the formulation of the law of variation of radiated energy with the geometric dimensions of the flames, by recording the mean absolute temperature.

J. J. PHIPPS

536.46

7905. Note on the validity of one-dimensional flame front models. R. M. FRISTROM. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1360–1 (*July*, 1955).

Studies of flow patterns through the flame front of a lean propane–air flame, involving determinations of gas density and velocity from continuity considerations and time-position information given by particle track studies indicate that all the flames are unidimensional in the reaction region and that if the burning velocity is defined as the normal gas velocity at the position of initial temperature rise, it is a function only of the initial state of the gas (composition, temperature and pressure). One-dimensional theories should be modified to assume $\rho va =$ const. instead of $\rho v =$ const., and diffusion and heat conduction equations should be generalized to include effects of expansion. The hydrocarbon flame reaction consists of a zone of fast propagating reaction in which most of the heat and light is emitted, and a slow zone of secondary reaction, in which reaction is time but not distance-dependent. R. C. MURRAY

536.46

7906. Mass transfer theories of fuel bed combustion. R. S. SILVER AND R. W. MACKAY. *Brit. J. appl. Phys.*, **6**, *No.* 8, 267–71 (*Aug.*, 1955).

Considerable interest in the possibilities of developing theories of combustion based on mass transfer ideas has resulted in a number of attempts which are not immediately capable of comparison. The purpose of the present paper is to clarify the general position reached as a result of previously published work with particular reference to combustion of carbon in solid fuel beds, and to enumerate the points on which certain of the more recent approaches agree or differ theoretically. The papers so chosen by Thring, Silver and Spalding respectively are used not because these were thought to be exhaustive, nor necessarily final, but because each uses a different approach and is amenable to the process of intercomparison. In this way it is hoped that an improved appreciation of the general theory will facilitate further advance. In terms of this basic general theory a method of evaluating an accurate transport parameter to describe a live fuel bed is suggested as a logical beginning for further progress. A.

536.48

7907. A note on the interatomic and lattice potentials in solid helium. D. J. HOOTON. *Phil. Mag.*, **46**, 701–10 (*July*, 1955).

The interatomic potential $\phi(r)$ has been recently re-determined from gaseous data by Yntema and Schneider [Abstr. 7073 (1950)] and by Mason and Rice [Abstr. 4268 (1954)]. In this determination the main significance comes from smaller values of r than are encountered in lattice dynamics; the same may be said for the simpler Lennard-Jones approximations, which have also been put forward at various times. It is suggested here that, for the purposes of lattice theory, a better approximation would be to choose a Lennard-Jones potential by directly fitting it, within the crystal range of r, to the most accurate gaseous estimate of $\phi(r)$ available. In illustration, a comparison of some quantities relevant to lattice dynamics is given for Yntema and Schneider's curve, and for a 6–12 Lennard-Jones potential fitted to it in this way. The characteristics of several recent or well-known estimates of $\phi(r)$ are tabulated, and the lattice potential Φ is calculated from the more important of them. The equivalence of the cubic and hexagonal close-packed structures is demonstrated, and its physical significance for helium is discussed. A.

536.48 : 535.34.07

An optical absorption cell for use at low temperatures. *See Abstr.* 7837

536.48 : 538.24

Demagnetization experiments on cerium ethyl sulphate. *See Abstr.* 8084

536.48

7908. Tentative on the role of exchange forces in the problem of He II. S. FRANCHETTI. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 159–60 (1955).

Preliminary note on theoretical work which involves atomic concepts and the two-fluid model and is supposed to account for the negative expansion coefficient of He II. The line of argument is broadly indicated but no details and no quantitative formulations are presented. R. EISENSCHITZ

536.48

7909. Superfluids. Volume II. Macroscopic theory of superfluid helium. F. LONDON. *New York: John Wiley; London: Chapman and Hall* (1954) xvi + 217 *pp.*

Review in *Proc. Phys. Soc. A*, **68**, *Pt* 7, 662 (*July*, 1955).

536.48

7910. Superfluidity in liquid He^3. M. J. BUCKINGHAM. Letter in *Phys. Rev.*, **98**, *No.* 6, 1855–6 (*June* 15, 1955).

According to the "pair-cell-model" the quantum

states of a liquid are represented in terms of the levels of an inhibited rotator consisting of two atoms. On account of density fluctuations all degrees of inhibition must contribute to the resulting energy spectrum. Between every pair of successive rotational states the energy spectrum is accordingly continuous. If the rotator consists of two fermions both odd and even rotational states are admissible. In consequence the spectrum is fully continuous. It is not possible to deduce anything like a gap in the spectrum on the basis of the present model. If the particles are bosons only even rotational states are admissible. In this case there is a finite gap between the lowest band and the first excited band. R. EISENSCHITZ

536.48

7911. Helium II film transport. II. The role of surface finish. B. SMITH AND H. A. BOORSE. *Phys. Rev.*, **99**, *No.* 2, 346–58 (*July* 15, 1955).

For Pt I, see Abstr. 5371 (1955). The effect of surface finish has been studied by comparing transport rates measured on four metal beakers (aluminium, nickel, stainless steel and nickel-silver), before and after they had been "superfinished." Deliberately roughened surfaces were employed in similar control experiments on glass. Measured values of beaker microfinish are reported for comparison with flow rates. The data obtained with these specimens, as well as with a nickel beaker whose inner wall was broached to provide, in effect, a capillary covered surface, are consistent with the hypothesis that transport rates adjust to the prevailing microscope perimeter and do not require the added hypothesis of anomalous flow in surface cracks. A scheme for estimating the difference between macro- and micro-perimeter is proposed, and the flow data are found to be consistent with its predictions. These include the result that a large increase in surface roughness may not imply a very large change in the microscopic perimeter "seen by the film." A.

536.48

7912. Helium II film transport. III. The role of film height. B. SMITH AND H. A. BOORSE. *Phys. Rev.*, **99**, *No.* 2, 358–66 (*July* 15, 1955).

Transport rates have been measured for film heights up to 5·3 cm. A variation with film height, whose average behaviour is similar to that which has been reported for the film thickness, was observed. This height dependence of the flow rates was found to be temperature independent in the range under investigation ($1°K \gtrsim T < T_\lambda$). The results are also relatively insensitive to changes in substrate and microfinish. Consideration of this height dependence was essential to the analysis of the rôle of substrate and microfinish presented in Pts I and II. A.

536.48

7913. Helium II film transport. IV. The role of temperature. B. SMITH AND H. A. BOORSE. *Phys. Rev.*, **99**, *No.* 2, 367–70 (*July* 15, 1955).

The study of film transport is concluded with a statistical analysis of the temperature dependence of the transport rates, with particular attention to the possibility of detecting systematic variations with substrate, surface finish, and film height. Analysis of 153 rate *v.* temperature characteristic curves reveals that the temperature dependence of the transport is relatively insensitive to changes in the aforementioned parameters. The functional dependence of the normalized, average transport rates for all materials, finishes, and film heights discussed in Pts I–III, is given by $[1-(T/T_\lambda)^7]$, in the temperature range under investigation ($1{\cdot}1°K \ll T < T_\lambda$). These results are compared with various theoretical predictions based on the two-fluid model of liquid helium as well as with relevant reports of other observers. A.

536.483

7914. Liquid nitrogen generator. S. C. COLLINS. *Rev. sci. Instrum*, **26**, *No.* 7, 671–6 (*July*, 1955).

A low-pressure laboratory liquefier having a capacity of 45 to 50 litres per hour is described. A combination of old and new features makes possible continuous operation without an attendant. Impurities such as water, carbon dioxide, and oil are eliminated automatically by reversing exchangers. The liquid nitrogen product flows directly from the rectifier to a large external storage vessel. The net power requirement is approximately 50 kW. A.

536.531

7915. A resistance thermometer for use at helium temperatures. D. H. PARKINSON AND L. M. ROBERTS. Note in *Proc. Phys. Soc. B*, **68**, *Pt* 6, 386–7 (*June*, 1955).

A single length of leaded brass wire annealed in a suitable temperature gradient can be made to possess an almost linear resistance-temperature characteristic. Results are given for one wire in which the maximum departures from linearity correspond to temperature errors of only ±0·02 deg. K. Details of the annealing procedure are given. F. E. HOARE

536.531

7916. Carbon resistor thermometers. F. E. HOARE, J. C. MATTHEWS AND B. YATES. Note in *Proc. Phys. Soc. B*, **68**, *Pt* 6, 388–9 (*June*, 1955).

Results of calibrations of a carbon resistor thermometer in the liquid/solid hydrogen and liquid helium ranges indicate that the reproducibility of the calibration curve is improved by using a reduced resistance rather than the absolute values. The resistance at the normal boiling points of hydrogen or helium serves as reference for the reduced values.

F. E. HOARE

536.532 : 536.581 : 621.316.7 : 621.317.32 : 621.375.2.024

7917. Low-level thermocouple amplifier and a temperature regulation system. T. M. DAUPHINEE AND S. B. WOODS. *Rev. sci. Instrum.*, **26**, *No.* 7, 693–5 (*July*, 1955).

A breaker-type d.c. amplifier suitable for measurement of thermocouple voltages as low as $10^{-2}\mu V$ is described. Mechanically driven "choppers" operating at 40 c/s are used to modulate the thermocouple signal and later demodulate the amplifier output. Both input and output are floating and may normally be operated connected to ungrounded circuits. Over-all voltage gain is approximately 10^7 while the zero error corresponds to less than $10^{-2}\mu V$ d.c. input within five minutes of turning on. The amplifier contains only standard components and details of a

suitable chopper which can be made in the laboratory are given. A temperature regulation circuit is described which is suitable for precision control of temperature in conjunction with a differential thermocouple. An indicated temperature match as close as 0·0002 deg. C has been obtained with a single couple. A.

536.587

7918. An electrically regulated thermostat for isothermal calorimetry. A. KELEN. *Appl. sci. Res. B*, **4**, *No.* 5, 309–16 (1955).

A detailed description of the construction and manner of operation of an electrically heated and regulated thermostat and equipment for isothermal calorimetry is given. The thermostat has a temperature constancy better than a thousandth of a degree per hour during long periods in the temperature interval from 450 to 35°C, and is intended to be useful up to 550°C. A.

536.6 : 539.172.4

7919. A calorimetric determination of the average kinetic energy of the fragments from U^{235} fission. R. B. LEACHMAN AND W. D. SCHAFER. *Canad. J. Phys.*, **33**, *No.* 7, 357–63 (*July*, 1955).

The average heat of thermal-neutron-induced fission of U^{235} has been measured by a differential calorimeter. The average energy per fission observed by the calorimeter was $170{\cdot}1 \pm 1{\cdot}2$ MeV. On the basis of the thicknesses of the calorimeter materials and the theoretical energy loss equation, the β-energy per fission observed by the calorimeter is $3{\cdot}0 \pm 1$ MeV and, on the same basis, the γ and neutron energy observed is negligible. The resulting $167{\cdot}1 \pm 1{\cdot}6$ MeV for the average kinetic energy of the fission products is shown to be in good agreement with less direct determinations of this quantity. A.

536.62

7920. A simple microcalorimeter for heat of solution measurements. W. P. HUTCHINSON AND A. G. WHITE. *J. sci. Instrum.*, **32**, *No.* 8, 309–14 (*Aug.*, 1955).

In an endeavour to simplify the temperature measuring equipment usually used in micro-calorimetric work the performance, in a calorimeter, of five different types of thermistor has been examined. The selection of a suitable type for a given purpose and of the correct operating conditions is discussed. Details of the construction of a microcalorimeter, which uses a Dewar vessel of 50 cm³ capacity and a thermistor as the temperature sensitive element, are given. Heat changes of approximately 1 cal can be measured with a precision of ±0·3%. A.

536.631

7921. Heat capacity of NiF_2 from 12 to 300°K. Thermodynamic functions of NiF_2. The thermal anomaly associated with the antiferromagnetic ordering. E. CATALANO AND J. W. STOUT. *J. chem. Phys.*, **23**, *No.* 7, 1284–9 (*July*, 1955).

The heat capacity of NiF_2 has been measured calorimetrically between 12 and 300°K. There is an anomaly in heat capacity rising to a maximum of $9{\cdot}23$ cal deg^{-1} mole^{-1} at 73·22°K. The anomaly is associated with the antiferromagnetic ordering of the magnetic moments of the nickel ions. Values of heat capacity, entropy, enthalpy and free energy are tabulated at selected temperatures. The entropy at 298·16°K is $17{\cdot}59 \pm 0{\cdot}04$ cal deg^{-1} mole^{-1}. For the reaction $NiF_2 + H_2 = Ni + 2HF$, $\Delta H_0^0 = 29{\cdot}56 \pm 0{\cdot}20$ kcal and $\Delta H^0 = 30{\cdot}06 \pm 0{\cdot}20$ kcal at 298·16°K. A.

536.631 : 536.48

7922. The specific heats of magnesium and zinc. P. L. SMITH. *Phil. Mag.*, **46**, 744–50 (*July*, 1955).

Specific heat measurements have been made on magnesium from 1 to 20°K and on zinc from 4 to 20°K. The magnesium data agree with the most recent measurements above 15°K, whilst the results on zinc confirm one set of earlier data. The shape of the curve of the Debye θ versus temperature for magnesium is found to be similar to that for beryllium. The θ value rises from a constant value of 326° above 30°K to 406° at absolute zero. The θ value for zinc rises much more sharply from a value of 195° at 20°K to 291° at absolute zero. A.

536.631 : 536.48

7923. The specific heats of lithium fluoride, sodium chloride and zinc sulphide at low temperatures. D. L. MARTIN. *Phil. Mag.*, **46**, 751–8 (*July*, 1955).

The specific heats were measured within the temperature range 2 to 30°K using a calorimeter of a novel type, upon which the crystal specimens were stuck with silicone grease. Ideally, these three substances have only a lattice contribution to their specific heats so that a direct comparison of the results with the theoretical predictions of the lattice theory of specific heats is possible. Good agreement between theory and experiment is found. The existence of a "T^3" region extending up to a temperature of about 20°K is shown clearly in the case of lithium fluoride. A.

536.631 : 536.48

7924. Specific heat of bismuth at liquid helium temperatures. K. G. RAMANATHAN AND T. M. SRINIVASAN. *Phys. Rev.*, **99**, *No.* 2, 442–3 (*July* 15, 1955).

This has been investigated in the liquid helium region down to 1·3°K by means of a new vacuum calorimeter. The Debye θ is found to increase from 103·5 to 120 in the range 4·1 to 2°K and appears to attain a constant value at lower temperatures. Evidence is obtained for an electronic contribution of $0{\cdot}114 \times 10^{-4}\ T$ calories/deg. K to the atomic heat of bismuth. A.

536.633

7925. New approach to the measurement of the specific heat of gases. S. C. COLLINS AND G. J. VAN WYLEN. *Rev. sci. Instrum.*, **26**, *No.* 6, 601–2 (*June*, 1955).

The variation of temperature with elevation within a body of gas in convective equilibrium in a gravitational field depends upon the specific heat. Specifically, the sum of the enthalpy and potential energy is the same for all elevations. It is only necessary, therefore, to measure the temperature at two points and the vertical distance between them to find the specific heat at the existing pressure. A calorimeter for securing an approximation to convective equilibrium is described. A.

THERMODYNAMICS 536.7/.8

536.7

7926. Application of Gibbs's equation to ionized substances. H. A. Zutrauen and L. Ter Minassian-Saraga. Letter in *J. Chim. phys.*, **52**, *No.* 4, 353–5 (*April*, 1955) In French.

An attempt at checking the applicability of Gibbs's equation in its integrated form to solutions of three surface-active electrolytes in the presence of an excess of KCl. The following substances were used: $[CH_3(CH_2)_{17}N(CH_3)_3]^+Cl^-$, $[CH_3(CH_2)_{15}N(CH_3)_3]^+Br^-$ and $[CH_3(CH_2)_{13}N(CH_3)_3]^+Br^-$. The absorption curves (surface pressure of the electrolyte *v.* concentration) obtained experimentally show a good agreement with the values calculated with the use of Gibbs's equation. F. LACHMAN

536.7

7927. Values of thermodynamic functions to 12 000°K for several substances. W. Fickett and R. D. Cowan. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1349–50 (*July*, 1955).

A graphical method of approximation was used to fit values in the range 3 000–5 000°K to those of the National Bureau of Standards, extrapolation gives values up to 12 000°K. A table of $(H^0-H_0^0)/RT$ is given for a number of diatomic and triatomic molecules and graphite. C. TURNER

536.7 : 530.162

7928. New approach to nonequilibrium processes. P. G. Bergmann and J. L. Lebowitz. *Phys. Rev.*, **99**, *No.* 2, 578–87 (*July* 15, 1955).

Proposes a new model for the description of irreversible processes, which permits the construction of a Gibbs-type ensemble and the employment of the general techniques of statistical mechanics. The internal dynamics of the system that is engaged in the process is assumed to be described fully by its Hamiltonian. Its interaction with the driving reservoirs is described in terms of impulse interactions (collisions). The reservoirs themselves possess definite temperatures, are inexhaustible, and free of internal gradients. The ensemble obeys an integro-differential equation in Γ-space, containing both the terms of the Liouville equation and a stochastic integral term that describes the collisions with the reservoirs. It is shown in this paper (1) that the ensemble will approach canonical distribution in the course of time in the presence of a single driving reservoir, (2) that it will approach a stationary nonequilibrium distribution in the presence of several reservoirs at different temperatures, and (3) that in the latter case, and for small temperature differences, Onsager's reciprocal relations are satisfied by the stationary distribution. A.

536.7 : 530.162

Statistical thermodynamics of mixture of Bose–Einstein and Fermi–Dirac liquids. *See Abstr.* 7713

536.7 : 539.501

7929. Deformation of viscoelastic plates derived from thermodynamics. M. A. Biot. Letter in *Phys. Rev.*, **98**, *No.* 6, 1869–70 (*June* 15, 1955).

An extension of previous theory [Abstr. 4615 (1955)] using a second-order displacement function. J. E. CAFFYN

536.75

7930. Entropy, heat capacity, and heats of transmission of 1,2,3-trimethylbenzene. R. D. Taylor, B. H. Johnson and J. E. Kilpatrick. *J. chem. Phys.*, **23**, *No.* 7, 1225–31 (*July*, 1955).

The heat capacity and the heats and temperatures of transition of 1,2,3-trimethyl benzene have been determined experimentally. The entropy of the ideal gas at 25°c and 1 atm has been found to be 91·98 ± 0·15 cal/deg. mole. A.

536.75

7931. Entropy, heat capacity, and heats of transition of 1,3,5-trimethylbenzene. R. D. Taylor and J. E. Kilpatrick. *J. chem. Phys.*, **23**, *No.* 7, 1232–5 (*July*, 1955).

The heat capacity and the heats and temperatures of fusion of 1,3,5-trimethylbenzene have been determined experimentally. This substance exhibits three melting points: at 228·424°K, at 223·346°K and at 221·462°K. The only solid phase having reproducible heat capacities was found to be the one having the highest melting point. The entropy of the ideal gas at 25°c and 1 atm pressure has been found to be 92·09 ± 0·15 cal/deg. mole. A.

ELECTRICITY 537

537.122

7932. On the size of the electron radius. H. Salecker. *Z. Naturforsch.*, **10a**, *No.* 5, 349–60 (1955) In German.

If the electron structure is thought of as being given by a form factor of the type introduced by Bopp and Feynman, then the field from this electron will deviate from a point charge at small distances. This effect is distinct from higher-order quantum electrodynamical corrections. Experimental deviations at large angles from the Møller and Bhaba theories of electron–electron and electron–positron scattering are explained by an electron radius of 10^{-12}cm. Possible corrections to the experiments are discussed. G. E. BROWN

537.122

7933. On the classical electrodynamics of the point electron. A. Loinger. *R.C. Accad. Naz. Lincei*, **18**, *No.* 3, 309–13 (*March*, 1955) In Italian.

An attempt is made to present a simple physically intuitive derivation of Dirac's classical 3rd-order equation of motion for the electron. In discussing the self-force, certain terms are eliminated as being merely the Lorentz transform of the static Coulomb force and others are combined with a fictitious rest mass to produce the observed mass of the electron. R. A. NEWING

ELECTROSTATICS . DIELECTRICS 537.2

537.21 : 621.3.013

7934. A general mathematical treatment applicable to certain electrode systems. G. Power. *Brit. J. appl. Phys.*, **6**, *No.* 7, 245–7 (*July*, 1955).

Some general formulae are obtained concerning the

perturbation effects on certain two-dimensional electric fields of dielectric cylinders, assumed homogeneous and isotropic, with various boundary shapes. By taking particular values for the dielectric constants, these formulae lead to results of interest for particular electrode systems. A.

537.213 : 541.183

7935. Studies in contact potentials. I. Determination of the surface potential of some films on tungsten and mercury by the condenser method and a new form of the thermionic method. J. C. P. MIGNOLET. *Recueil Trav. chim. Pays-Bas*, **74**, *No.* 6, 685–700 (*June*, 1955).

Describes first a new form of the thermionic method based on the shift of resistance characteristics. The resistance of the diode is measured with an a.c. bridge, care being taken to keep the emitter at constant temperature, even in the presence of gas. Cells suitable for tungsten deposits are described. The WH, WXe and HgXe films have been studied by both the thermionic and the condenser method, and excellent agreement has been found for the surface potentials. For the WH and WN films, the surface potentials obtained are in grave disagreement with those of Bosworth (1937) and of Bosworth and Rideal (1937) on tungsten wires. It is shown that Bosworth's value cannot refer to a WH film. The work function of a deposit stabilized between 293 and 428°K is close to that of a polycrystalline wire. Sintering increases the work function. A.

537.213 : 541.183

7936. Studies in contact potentials. II. The competitive adsorption of hydrogen atoms and molecules on tungsten. J. C. P. MIGNOLET. *Recueil Trav. chim., Pays-Bas.*, **74**, *No.* 6, 701–28 (*June*, 1955).

Surface potential measurements show the adsorption of hydrogen on tungsten to be complex. Besides the negative effect due to the familiar atomic film, a positive effect is observed. Experimental evidence reveals two important points, viz. (i) the positive effect is due to a molecular adsorption, and (ii) at the approach of saturation, the latter is able to compete with the atomic adsorption. The properties of the mixed adsorption of atoms and molecules on a surface are examined theoretically. Three main conclusions are reached. The competition between the atomic and molecular adsorptions may give rise to a special mode of adsorption, consisting in the replacement of atoms by molecules and taking place near saturation on a surface with practically no vacant sites. Through substitution, a molecular adsorption may compete with an atomic adsorption with double the differential heat of adsorption. The saturated mixed film is normally non-stoichiometric. The model provides a satisfactory explanation of some peculiarities of the positive effect. The high heat of the molecular adsorption (up to 8 kcal/mole) is to be attributed essentially to the charge transfer forces, the contribution of which is much greater than that of the dispersion forces. Using the above ideas, it is shown that the evidence regarding the catalytic hydrogen exchange at low temperature is in favour of the Rideal mechanism. Substitutional adsorption is an activated process. It may account for a part of certain effects frequently attributed to dissolution. A.

537.221

7937. On the question of electrostatic charging of flowing liquids. B. HAMPEL AND H. LUTHER. Letter in *Naturwissenschaften*, **42**, *No.* 9, 252–3 (1955) In German.

Measurements of the dependence of charging current upon the concentration of various polar impurities in *n*-heptane flowing in a Pt capillary tube are described and discussed in relation to previous work.

C. G. MORGAN

537.226

7938. The dielectric polarization of polar liquids. M. MANDEL. *Bull. Soc. Chim. France*, **1955**, *No.* 7–8, 1018–25 (*July–Aug.*) In French.

A general survey is given of the theories of Kirkwood, Fröhlich, Onsager and Böttcher. The approximations used in each are listed, and it is concluded that Fröhlich's is the best approach to the exact calculation of dielectric constants, and that it offers the best possibilities of solving the statistical problems involved. A. J. TAYLOR

537.226.2

7939. Microwave dispersion of some polar liquids. J. P. POLEY. *Appl. sci. Res. B*, **4**, *No.* 5, 337–87 (1955).

An outline of the problem and an historical survey of experimental work on the dielectric behaviour of polar liquids are given. A number of theoretical expressions for the dielectric constant in the static case and their extension to alternating fields are reviewed. A formula for the dielectric dispersion in liquids composed of ellipsoidal molecules is derived and its consequences are investigated, experimental details being given. A new microwave measuring technique is described, accurate in most cases to about 1% for both the real and imaginary part of ε. In order to make the theories applicable, the investigation has been restricted mainly to polar liquids of simple structure, in particular to the mono-substituted benzenes. The results refer to wavelengths down to 0·8 cm. The analysis of the measurements reveals discrepancies between the dielectric constant ε_∞, extrapolated from the side of cm-waves, and n^2, the square of the refractive index, extrapolated from measurements in the visible and infrared. This leads to assuming an additional region of dipolar absorption in the neighbourhood of 1 mm. The mechanism to which such an absorption may be due is sought in the strong local fields exerted on a molecule by its immediate neighbours. A.

537.226.2 : 541.64

7940. On the interpretation of dielectric constants of aqueous macromolecular solutions. Hydration of macromolecules. B. JACOBSON. *J. Amer. Chem. Soc.*, **77**, *No.* 11, 2919–26 (*June* 5, 1955).

Two preparations of sodium desoxyribonucleate were investigated with a streaming dielectric technique in which the macromolecules were hydro-dynamically oriented in relation to the electric field. For one preparation the dielectric increment of the solutions was independent of the velocity gradient. For the other preparation, which was highly thixotropic, a small decrease in dielectric constant was observed when the electric field was perpendicular to the stream lines. In a second series of experiments

the dependence of the dielectric constant upon frequency was determined in mixtures of water and thoroughly washed filter paper. In a mixture containing approximately 20% filter paper the dielectric constant decreased with increasing frequency from 109 at 0·1 Mc/s to 98 at 10 Mc/s. The value for pure water is 80·3 and that for dry filter paper is below 7 at these frequencies. The macromolecular rotation theory for explaining the dielectric properties of macromolecular solutions is evaluated in view of existing experimental data. The theory is found to be invalid for some asymmetric polyelectrolytes which give high dielectric increments, and it is very likely incorrect for the proteins. Other existing theories cannot satisfactorily explain certain streaming dielectric effects, that is a change in dielectric properties with increasing velocity gradient in the solution. Therefore, a new hypothesis is suggested according to which the dielectric properties arise from a structural change in the water lattice. Through hydrogen bonding the macromolecular surface stabilizes the surrounding water to form lattice-ordered (ice-like) hydration shells. In certain cases these shells can have a diameter of at least one fourth of the length of an asymmetric macromolecule. The lattice order in the hydration shells is greater close to the macromolecular surface than it is farther away from it. The hypothesis can give a satisfactory qualitative explanation for experimental dielectric observations mentioned, as well as for certain other data on the viscosity, proton magnetic resonance and X-ray diffraction of macromolecular solutions. A.

537.226.2 : 621.315.615.: 621.317.335.3

7941. The measurement of the dielectric constant of standard liquids. L. Hartshorn, J. V. L. Parry and L. Essen. *Proc. Phys. Soc. B*, **68**, *Pt* 7, 422–46 (*July*, 1955).

New determinations have been made of the dielectric constants of benzene, cyclohexane, dichlorethane and nitrobenzene to provide values of a higher accuracy than has hitherto been available for four standard liquids covering the range of values commonly required. Liquids of specially high purity were obtained, and the measurements were made by the a.c. bridge technique developed at the National Physical Laboratory for precision capacitance measurement and also by a cavity resonator method. Pt I discusses the general problem and the special features of the capacitor designed to receive the liquids and surveys the results obtained. Pt II gives details of the measurements made by capacitance methods at frequencies from 50 c/s to 10 kc/s, and Pt III describes the measurements made at microwave frequencies. The values obtained confirm estimates of the most reliable values and their probable accuracy published as a result of a survey of existing data made at the National Bureau of Standards, Washington [Abstr. 1768 (1952)]. It is considered that the new values narrow the range of uncertainty by a factor varying from 3 to 10 for the different liquids. The accuracy obtained for benzene at audio frequencies was ~0·01%; at 9 000 Mc/s the accuracy was a trifle worse but the results show clearly that although the dielectric constant exceeds the square of the optical refractive index by about 1%, no measurable diminution in dielectric constant occurs in passing from 50 c/s to 9 000 Mc/s. A considerable increase in power absorption is, however, noticeable at 9 000 Mc/s and an even greater increase at 25 000 Mc/s, and it is shown that this absorption is not entirely dependent on the water that most samples of benzene contain and that can only be removed by weeks of drying treatment. The necessity of applying such treatments is a serious disadvantage to the use of benzene as a standard liquid for measurements of dielectric constant, and cyclohexane, which is free from this disadvantage, is recommended instead. A.

537.226.2 : 534.22

Ultrasonic velocities in polarized barium titanate ceramics. *See Abstr.* 7771

537.226.3 : 548.7

7942. Theory of dielectric relaxation for a single-axis rotator in a crystalline field. II. J. D. Hoffman. *J. chem. Phys.*, **23**, *No.* 7, 1331–9 (*July*, 1955).

For Pt I, see Abstr. 3454 (1954). Previous work on the relaxation times associated with a polar single-axis rotator where the dipole may occupy three or four orientational sites by turning in a lattice point has been extended to include the more general case where the energies of the sites (as well as the intervening barriers) are all different. The results for these more general models tend to confirm the view that the presence of barriers of different magnitudes between the equilibrium orientations of a dipole can be the source of a set of discrete dielectric relaxation times. The dielectric properties of some specialized three- and four-position models are then considered in detail. A very narrow or an extremely wide set of relaxation times can be obtained depending on the nature of the barrier system, and accordingly, a wide range of dielectric behaviour can be accommodated. Despite the wide range of behaviour, certain qualitative features appear to persist in many of the models. These features may be useful in applying the theory in a general way. The equations given will facilitate the calculation of the properties of three- and four-position models not already considered. A.

537.226.8

7943. An interesting phenomenon observed on some dielectrics. I. Sumoto: Note in *J. Phys. Soc. Japan*, **10**, No. 6, 494 (*June*, 1955).

A glass tube, placed between two metal electrodes and immersed in certain polar dielectric liquids, is reported to rotate when a d.c. stress of a few kV/cm is applied between the electrodes. J. H. MASON

537.228.2 : 537.226.2

7944. Electrostriction. H. F. Kay. *Rep. Progr. Phys.*, **18**, 230–50 (1955).

The term ferroelectricity is briefly introduced and the properties of the perovskite-structure mixed-oxide group are reviewed with special reference to $BaTiO_3$. The distinction between piezoelectricity and electrostriction is explained in some detail, and the relevant expressions relating the electrical and mechanical properties are discussed for both the single crystal and ceramic specimens. It is pointed out that there is still considerable doubt as to the exact mechanism involved, especially in the case of the ceramics when

electrical stresses are applied, and simplified models are discussed to demonstrate the factors contributing to the resultant strain. Single crystals are then discussed in detail, with a survey of the methods of growth and results of striction and hysteresis loop measurements; the most likely interpretation of these results is discussed. Similarly the more complicated ceramic materials are dealt with, and it is shown that measured values of the striction constants conform reasonably with theory, but further analysis is still needed to account for small discrepancies. Time-dependent effects are also described and tentative explanations given. Brief mention is made of other oxide materials and possible directions of future research. 56 references. A.

537.242

7945. Singularities of the speed of precipitation of submicronic particles in ionizing electric fields. M. PAUTHENIER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 18, 1761–3 (*May* 2, 1955) In French.

A continuation of previous work [see Abstr. 6121 (1955)]. The charge acquired by a particle ($\lesssim 10^{-7}$ cm) as a function of the time spent in the field is calculated and indicates a logarithmic growth of charge with time. Further considerations suggest that there is a minimum speed of precipitation for submicronic particles. C. G. MORGAN

ELECTRIC CONDUCTION . CURRENTS 537.3

537.311.33 : 621.38 : 621.316.8 : 621.315.59

7946. Phenomenological approach to "current noise." D. A. BELL. *Brit. J. appl. Phys.*, **6**, *No.* 8, 284–7 (*Aug.*, 1955).

There is no satisfactory theory of the noise additional to Johnson noise found when a steady current is passed through resistors made of any kind of semiconducting material. Experiments by various workers have failed to show conclusively that it is an interface phenomenon. Rough estimates are given of the total fluctuation (all frequencies) and the number N of charge carriers present in 3 examples, and the relative fluctuations are shown to be $\gg 1/N$. The inverse-frequency spectrum cannot be a result of a particular pulse shape, but could possibly be due either to a complicated diffusion process or more probably to the law relating mean-square perturbation and time for the whole population of carriers which is not to be regarded as an equilibrium system. A.

537.311.33

7947. Physical theory of semiconductor surfaces. C. G. B. GARRETT AND W. H. BRATTAIN. *Phys. Rev.*, **99**, *No.* 2, 376–87 (*July* 15, 1955).

The properties associated with the space-charge region and with surface states at a semiconductor surface are discussed. A theory of the space-charge region that takes into account charge-densities arising from immobile impurities and from both signs of mobile carrier is presented. The properties of the space-charge are discussed in terms of the surface potential and of the electrochemical potentials of holes and electrons, and related to the transport of added carriers in a homogeneous semiconductor. The change in surface conductivity arising from non-vanishing surface excesses of holes and electrons is treated. The space-charge systems at a free surface and at a p–n junction are compared, and the range of validity of the Mott–Schottky space-charge theory evaluated. The arrangement of surface states is discussed with reference to the Brattain–Bardeen model. Theories for the surface photoeffect and field-effect experiments are given, with and without surface states: it is concluded that the existence of surface states is without gross effect on the former, while relevant quantitative evidence from the latter is not yet available. The question of the relation between surface potential and contact potential is discussed. The properties of "channels" are discussed in terms of the theory. The paper concludes with a short section on long-time effects. A.

537.311.33 : 621.315.59 : 621.317.73

7948. Apparatus for measuring resistivity and Hall coefficient of semiconductors. T. M. DAUPHINEE AND E. MOOSER. *Rev. sci. Instrum.*, **26**, *No.* 7, 660–4 (*July*, 1955).

Using a new type of measuring circuit, the apparatus combines the best features of both a.c. and d.c. apparatus. Thus, on the one hand, errors due to thermal e.m.f.'s and the Ettingshausen effect are eliminated while, on the other hand, the one necessary balance is still made on a simple d.c. potentiometer with a d.c. galvanometer as null indicator. Contact and lead resistances do not affect the readings. Results of resistance and Hall coefficient measurements on a germanium specimen are given as an indication of performance. A.

537.311.33 : 621.315.59 : 621.317.34

7949. Noise measurements in semiconductors very low frequencies. T. E. FIRLE AND H. WINSTON. *J. appl. Phys.*, **26**, *No.* 6, 716–18 (*June*, 1955).

The low-frequency noise spectra of germanium and silicon rectifiers have been determined. Two methods were employed: a numerical analysis according to the Wiener–Khintchine relationship, and a frequency translation photo playback method. No evidence of a deviation from a $1/f^a (a > 1)$ noise power law was found down to frequencies as low as 6×10^{-5} c/s. A.

537.311.33 : 621.317.31 : 621.315.59

7950. A pulse method for measuring the injection ratio of metal–semiconductor contacts. G. G. E. LOW. *Proc. Phys. Soc. B*, **68**, *Pt* 7, 447–52 (*July*, 1955).

The current through the contact is applied as a series of constant current pulses and the change in conductance of the specimen is measured as a function of time. The method is suitable for measurements at low emitter currents. Measurements have been carried out for tungsten point contacts on n-type and p-type germanium and results of injection ratio as a function of emitter current are given. A.

537.311.33 : 541.183

7951. The adsorption of gases on a germanium surface. J. T. LAW. *J. phys. Chem.*, **59**, *No.* 6, 543–9 (*June*, 1955).

The adsorption of hydrogen, nitrogen, carbon monoxide and carbon dioxide on a germanium surface

has been studied as a function of temperature. Various methods used for cleaning the surface are discussed. The results indicate that for all the gases studied, except hydrogen, the adsorption is purely physical and might be expected to have but little effect on the electrical properties of the semiconductor. A.

537.311.33 : 537.533.9

7952. Electron voltaic study of electron bombardment damage and its thresholds in Ge and Si. J. J. Loferski and P. Rappaport. Letter in *Phys. Rev.*, **98**, *No.* 6, 1861–3 (*June* 15, 1955).

The minority carrier lifetime in Ge and Si diodes is linearly related to the square of the shorted current flowing under electron excitation of the specimen as a voltaic cell. Variation of this quantity with electron dosage and energy provides a very sensitive measure of radiation damage compared with resistivity measurements. From the data threshold energies for electron bombardment damage are obtained; $\leqslant 23$ eV for Ge and $\leqslant 27$ eV for Si. G. F. J. Garlick

537.311.33

7953. New radiation resulting from recombination of holes and electrons in germanium. J. R. Haynes. Letter in *Phys. Rev.*, **98**, *No.* 6, 1866–8 (*June* 15, 1955).

Recombination radiation at $1{\cdot}8\,\mu$ has been observed by several authors. By the use of a water filter for the tungsten light source and very thin specimens (1×10^{-3} cm or less) of germanium a second maximum is found at a wavelength of $1{\cdot}5\,\mu$. The results are in agreement with a theory due to van Roosbroeck and Shockley (1954). C. A. Hogarth

537.311.33 : 536.48

7954. Electrical properties of germanium semiconductors at low temperatures. H. Fritzsche. *Phys. Rev.*, **99**, *No.* 2, 406–19 (*July* 15, 1955).

Low-temperature anomalies in the Hall coefficient and electrical resistivity—a steep maximum and a change of the slope of the log resistivity *v.* $1/T$ curve in germanium semiconductors—which were first observed by Hung and Gliessman, have been reinvestigated at temperatures between 1·5 and 300°K using single crystals of *n*- and *p*-type germanium of various impurity concentrations. The influence of contacts and of various surface treatments has been studied. It was found that the effects observed cannot be explained by surface conduction. To exclude electrical field effects at low temperatures, fields well below the breakdown field have been used. The Hall coefficient was measured with magnetic fields ranging from 100 to 3 500 gauss. Measurements on crystals cut in different crystal orientations show that the anomalies cannot be due to directional effects. In the same temperature region where the Hall effect and resistivity become anomalous, the magnetoresistive ratio also shows a drastic change. Throughout the whole temperature range the sample type, *n* or *p*, is retained. The results indicate that in order to describe the observations it seems necessary to assume conduction in at least two bands, the regular conduction band (valence band in the case of *p*-type material) and one band with a very small mobility. Hung's model of impurity band conduction has to be refined considerably or altered to account for the complicated behaviour of germanium samples with impurity contents between 2×10^{16} and 7×10^{16} acceptors/cm^3 or between 3×10^{16} and 1×10^{17} donors/cm^3. A.

537.311.33 : 536.48

7955. Electrical properties of *p*-type indium antimonide at low temperatures. H. Fritzsche and K. Lark-Horovitz. *Phys. Rev.*, **99**, *No.* 2, 400–5 (*July* 15, 1955).

The electrical resistivity ρ, Hall coefficient R, and transverse magnetoresistive ratio $\Delta\rho/\rho$ of *p*-type single crystals of indium antimonide have been measured between 370 and 1·5°K. Low-temperature anomalies similar to those observed by Hung on germanium have been found, a steep maximum in the log R *v.* $1/T$ curve and a change of slope of the log ρ *v.* $1/T$ curve. Contrary to the case with germanium, the magnetoresistive ratio of InSb does not vanish in the lowest temperature range, but it changes its sign from positive to negative as the sample is cooled to a temperature somewhat lower than that at which the Hall coefficient reaches its maximum value. Negative values of the magnetoresistive ratio cannot be explained by the usual theory of semiconductors. At the present time it also is not clear how Hung's model of impurity band conduction can account for negative values of the magnetoresistive ratio. A.

537.311.33

7956. Effect of pressure on the electrical conductivity of InSb. R. W. Keyes. *Phys. Rev.*, **99**, *No.* 2, 490–5 (*July* 15, 1955).

The electrical conductivity of InSb has been measured as a function of temperature from −78 to +300°C and pressures up to 12 000 kg/cm^2. It is found that the activation energy increases at a rate $15{\cdot}5\times10^{-6}$ eV/(kg/cm^2), that the electron mobility is approximately inversely proportional to the activation energy, and that the hole mobility is independent of pressure. On the basis of these mobility effects it is concluded that the k of the valence band energy extremum is not zero. An examination of the effects of pressure and temperature above 200°C suggests that there are three or four equivalent energy minima in the conduction band. A.

537.311.33

7957. Electrical conductivity induced in MgO crystals by 1·3-MeV electron bombardment. M. A. Pomerantz, R. A. Shatas and J. F. Marshall. *Phys. Rev.*, **99**, *No.* 2, 489–90 (*July* 15, 1955).

Currents induced by the passage of a pulsed beam of essentially monoenergetic 1·3 MeV electrons through thin single crystals of MgO have been observed. The bombardment-induced current is proportional to the applied voltage in accordance with theoretical expectation. The lifetime of the charge carriers before trapping is approximately 3×10^{-11} sec. A.

537.311.33 : 537.32

7958. Electrical conductivity and Seebeck effect in $Ni_{0.80}Fe_{2.20}O_4$. F. J. Morin and T. H. Geballe. *Phys. Rev.*, **99**, *No.* 2, 467–8 (*July* 15, 1955).

These have been measured as functions of temperature on single crystal samples. A thermal hysteresis has been observed in the conductivity but not in the Seebeck effect. This suggests that the hysteresis involves the charge carrier transfer process but not the

production of carriers. The activation energy associated with the transfer process is estimated to be 0·10 eV in the high-temperature state and 0·06 eV in the low-temperature state. A.

537.311.33

7959. Interpretation of donor state absorption lines in silicon. W. KOHN. Letter in *Phys. Rev.*, **98**, *No.* 6, 1856–7 (*June* 15, 1955).

See Abstr. 4660 (1955). A theory of Kohn and Luttinger is shown to explain the experimental results of Burstein, Picus and Henvis on the absorption in arsenic- and phosphorus-doped silicon. The ionization energies of the ground states are found to be: As, 0·053 3 ± 0·000 3 eV; P, 0·045 5 ± 0·000 3 eV.

C. A. HOGARTH

537.311.33 : 621.314.63

7960. Forward characteristic of germanium point contact rectifiers. M. CUTLER. *J. appl. Phys.*, **26**, *No.* 8, 949–54 (*Aug.*, 1955).

A quantitative discussion is given. It shows that the theoretical value of $d\ln I/dV$ in the exponential region is nearly q/kT, and that the experimental slopes which are a fraction of this value cannot be the result of the spreading voltage. Recombination of injected carriers has little effect at large currents beyond the exponential region. Relations are derived for the limit of very large currents, which show that γ approaches a value smaller than $(1 + b)^{-1}$, the hole concentration at the contact approaches a maximum value proportional to the equilibrium concentration of holes at the surface, and the spreading voltage becomes a linear function of the current. A.

537.311.33 : 621.314.7

7961. Silicon *n–p–n* grown junction transistors. M. TANENBAUM, L. B. VALDES, E. BUEHLER AND N. B. HANNAY. *J. appl. Phys.*, **26**, *No.* 6, 686–92 (*June*, 1955).

These have been made from rate-grown single crystals. Using gallium and antimony as doping agents, single crystals of *n*-type silicon have been grown containing up to five *p*-regions from 0·000 5 to 0·002 in. wide which are suitable for the production of transistors. The ohmic contact to the *p*-type base region was made by alloying an aluminium wire using techniques similar to those employed in the fabrication of aluminium–silicon diodes. The electrical evaluation of *n–p–n* transistors produced from these single crystals is described. Alphas in excess of 0·9 at — 1 mA emitter current have been obtained, and collector saturation currents of 10^{-6} A/cm^2 are common. With base-layer widths of about 0·000 5 in., the α-cutoff occurs at approximately 5 Mc/s. The units (approximately 0·04 × 0·04 × 0·5 in. in size) have been operated at power levels in excess of 1·5 W in air with no special provision for heat dissipation. A.

537.311.33 : 621.314.7

7962. A germanium point-contact transistor to operate at high ambient temperatures. A. F. GIBSON, J. W. GRANVILLE AND W. BARDSLEY. *Brit. J. appl. Phys.*, **6**, *No.* 7, 251–4 (*July*, 1955).

Under suitable conditions, minority carriers can be swept out of a bar of germanium by application of an electric field. The density of minority carriers is kept small and one of the causes of the large temperature coefficients of transistor characteristics, namely the rapidly increasing density of minority carriers with increasing temperature, is suppressed. This paper describes the application of this technique to germanium point-contact transistors. A significant improvement in high-temperature performance and speed of operation is obtained at the cost of increased complexity in assembly. A.

537.311.33 : 621.317.331 : 621.314.63

7963. The determination of the dynamic properties of crystal diodes. G. STUART-MONTEITH. *Brit. J. appl. Phys.*, **6**, *No.* 7, 254–6 (*July*, 1955).

The a.c. properties of a crystal diode biased in the forward direction are discussed, and are shown to depend both on the frequency and magnitude of the applied voltage. A method is given for determining the dynamic resistance, the results obtained agreeing with the theory. A.

537.312.5

7964. On the preparation of sensitive PbSe photocells. H. GOBRECHT, F. NIEMECK AND F. SPEER. Note in *Naturwissenschaften*, **42**, *No.* 6, 152 (1955) In German.

Describes briefly the preparation of photoconductive layers whose limit at 20°C is 4·5 microns.

C. A. HOGARTH

537.312.5

7965. Influence of infrared rays on the photoconductivity of the polycrystalline CdS. S. YOSHIMATSU, C. KANZAKI, S. IBUKI AND N. MURAI. Note in *J. Phys. Soc. Japan*, **10**, *No.* 6, 493 (*June*, 1955).

Diminution of photocurrent in polycrystalline and single crystal specimens of CdS is produced by near infrared irradiation with maximum effect for 1·45 μ and 0·85 μ (single crystal), 0·97 μ (polycrystalline).

G. F. J. GARLICK

537.312.5

7966. The effect of adsorbed air on photoconductive layers of lead sulphide. M. SMOLLETT AND R. G. PRATT. Letter in *Proc. Phys. Soc. B*, **68**, *Pt* 6, 390–1 (*June*, 1955).

Adsorbed oxygen on PbS increases the time constant and photoconduction response but mobility remains constant. The results suggest that oxygen forms surface trapping states. Nitrogen and argon have no effect on the photoconduction.

G. F. J. GARLICK

537.312.5

7967. D.C. photoconductivity technique for the determination of lifetime of minority carriers in silicon filaments. S. MAYBURG. Letter in *Rev. sci. Instrum.*, **26**, *No.* 6, 616–17 (*June*, 1955).

Outline of a steady-state method for determining carrier lifetime using a high sweeping field. Only very simple apparatus is required. C. A. HOGARTH

537.312.5

7968. Photoconductivity of stibnite (Sb_2S_3). S. IBUKI AND S. YOSHIMATSU. *J. Phys. Soc. Japan*, **10**, *No.* 7, 549–54 (*July*, 1955).

The results obtained up to the present are as follows: the maximum spectral sensitivity at room temperature is found at the wavelength of 770 mμ and with the rise of temperature it shifts to the longer

wavelength side; the photocurrent when illuminated by illuminant A varies with half power of the light intensity between 1 and 100 foot-candles; the thermal activation energy for the dark current is 0·48 eV between room temperature and 200°C and temperature dependence of the photocurrent is also investigated; the time lag of response is about 3 msec for the base photocurrent of 10 μA; Moss's constant, n^4/λ, is calculated to be 82 from measurements on dielectric constant and refractive index; the crystal is found to be an *n*-type semiconductor from its rectifying characteristics; the response for X-rays is fairly high, while that for u.v. rays, β-rays or γ-rays, is low. A.

537.312.5

7969. Photoelectric work functions of the borides of lanthanum, praseodymium, and neodymium. R. W. DECKER AND D. W. STEBBINS. *J. appl. Phys.*, **26**, *No.* 8, 1004–7 (*Aug.*, 1955).

The DuBridge variation of the Fowler theory of photoelectric emission was utilized to determine the work function of the borides of La, Pr and Nd. The work functions of LaB_6, PrB_6 and NdB_6 were found to be 2·7 eV, 3·12 eV and 4·57 eV, respectively. A.

537.312.5 : 537.311.33

7970. The theory of a bulk photo-voltaic phenomenon in semi-conductors. J. TAUC. *Czech. J. Phys.*, **5**, *No.* 2, 178–92 (*April*, 1955).

It is shown theoretically that for a photovoltaic phenomenon in semiconductors to exist neither the presence of localized potential barriers with rectifying properties at the contact of a semiconductor with a metal [Mott's theory (1939)] or at a *p–n* junction [Sosnowski (1947)] nor the presence of non-rectifying contacts [Dember's phenomenon, Lashkarev's theory (1948)] is necessary. The case is considered that the illuminated part of the semiconductor is sufficiently distant from both contacts so that these will not assert themselves; further, it is assumed that there are no localized potential barriers in the semiconductor. Under these conditions a photovoltage is produced in a semiconductor if its conductivity varies throughout its length in such a way that in the dark it is different at the beginning and end of the illuminated part. For this type of "non-barrier and non-contact" photovoltage the name "bulk" photovoltage is proposed. The underlying law of this phenomenon, the general procedure for calculating the photovoltage, an approximation for weak illumination and the dependence on the intensity of illumination are derived and its physical aspects are discussed. A.

537.312.5 : 539.231

7971. On the preparation of photosensitive cadmium sulphide layers by cathode sputtering. G. HELWIG AND H. KÖNIG. *Z. angew. Phys.*, **7**, *No.* 7, 323–5 (1955) In German.

Cathode sputtering of cadmium was carried out in an atmosphere of 25% H_2S, 75% A at 10^{-2} to 10^{-1} atm which produced a deposited layer of CdS. Layers were heat treated in air and change in photoconductivity observed. G. F. J. GARLICK

537.312.5 : 621.383

7972. High-sensitivity photoconductor layers. S. M. THOMSEN AND R. H. BUBE. *Rev. sci. Instrum*, **26**, *No.* 7, 664–5 (*July*, 1955).

High-sensitivity "powder" layers and "sintered" layers have been prepared in large-area form, with most of the desirable characteristics of single crystals. The methods involved in the preparation of these layers are simple and avoid the difficulties involved in growing large-area single crystals, or in producing large-area photoconductors by evaporation in vacuum. Both types of layers can be made into photocells of any desired area, by providing suitable electrodes. At an illumination of 1 ft-c, ratios of photocurrent to dark current as large as 10^6 may be obtained for both types of layers. A two-inch square cell made from either a powder or a sintered layer can pass an ampere for an illumination of a few foot candles. In addition to their ease of fabrication, the new layers also have advantages in the large increase in red sensitivity obtainable with cadmium sulphide, and in the ohmic character of sintered layers with silver-paste electrodes. A.

537.312.6

7973. Comments on the variation of resistivity with temperature of ceramics based on the oxides of manganese and nickel. J. SUCHET. *J. Phys. Radium*, **16**, *No.* 5, 417–22 (*May*, 1955) In French.

The resistivity of ceramics made from oxides of manganese and nickel does not vary with temperature in accordance with the simple Wilson theory. The anomalous variation is very dependent on the mode of preparation. The behaviour is explained by a model involving surface layers on the grains and which fits previous experimental results of other workers. C. A. HOGARTH

537.312.62

7974. The structures of superconductors. VIII. X-ray and metallographic investigations of the system bismuth–rhodium. N. N. ZHURAVLEV AND G. S. ZHDANOV. *Zh. éksper. teor. Fiz.*, **28**, *No.* 2, 228–36 (1955) In Russian.

For Pt VII, see Abstr. 11567 (1954). The existence of three phases Bi_4Rh, Bi_2Rh and BiRh in the Bi–Rh system was confirmed. Bi_4Rh occurs in three modifications; α–Bi_4Rh stable below 310°, cubic with $a = 14·928 \pm 0·005$ Å, $Z = 24$, $\rho_{obs.} = 11·0$ and space group $I\bar{4}3d$. β–Bi_4Rh is produced by quenching from 310–390° and is orthorhombic with $\rho_{obs.} = 10·7$. γ–Bi_4Rh is produced by quenching from 390–433° and appears hexagonal with $\rho_{obs.} = 10·7$. Two modifications of Bi_2Rh were found. α–Bi_2Rh is stable below 498° and is orthorhombic with $a = 5·9 \pm 0·3$, $b = 6·8 \pm 0·3$, $c = 7·2 \pm 0·3$ Å, $Z = 4$ and $\rho_{obs.} = 12·2$. β–Bi_2Rh, produced by quenching from 498–774° is monoclinic with $a = 16·2 \pm 0·1$, $b = 7·0 \pm 0·1$, $c = 10·5 \pm 0·1$ (c may possibly be 10·3, there is a misprint in the paper), $\beta = 92° 30'$, $Z = 16$ and $\rho_{obs.} = 11·4$. Phases richer in Rh than BiRh are composed of BiRh and Rh only. The solubility of Bi in Rh is too small to be detected by change in cell dimensions. Microhardness measurements were also made. A. L. MACKAY

537.312.62

7975. The kinetics of destruction of superconductivity by a magnetic field. A. A. GALKIN AND P. A. BEZUGLYĬ. *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 463–70 (1955) In Russian.

A superconducting tin or mercury cylinder was the core of a mutual inductance and the e.m.f. across the

secondary was studied oscillographically in the presence of various steady magnetic fields for various amplitudes of the primary alternating field (such that the total field was above critical for part of each cycle) and for various frequencies. From the results it is deduced in agreement with Lifshitz's theory [Abstr. 1016 (1952)] that the velocity of displacement of the boundary between superconducting and normal phases varies as ω/σ (σ = conductivity) but that the depth of destruction of superconductivity varies rather more rapidly with the excess of field over the critical than is predicted by the theory. It is estimated that the time of creation of a normal nucleus is $<10^{-6}$ sec but the time of creation of a superconducting nucleus is $\sim 1{\cdot}5\times10^{-4}$ sec. D. SHOENBERG

537.312.62

7976. An empirical rule for the position of the superconductors in the periodic system of the elements. R. GLOVER, III. *Z. Phys.*, **140**, *No.* 5, 494–7 (1955) In German.

All those elements are not superconducting which either do not possess three electrons in the outer shell or do not permit the construction of such a configuration without destruction of a rare gas configuration in the lower shells. No superconducting alloy consists exclusively of elements which cannot become superconducting according to this rule. H. LONDON

537.312.62

7977. Superconductivity and resistance of thin indium films with lattice faults and foreign metal additions. W. OPITZ. *Z. Phys.*, **141**, *No.* 3, 263–76 (1955) In German.

The resistance and superconductivity of thin indium films was studied and as in the work of Buckel and Hilsch [Abstr. 5794 (1952)] on tin, it was found that lattice faults were increasingly "frozen-in" as the condensation temperature was lowered, and that the transition temperature T_c rose correspondingly from 3·37 to 4·2°K. Addition of a few percent of Cu, Pd or Zn raises T_c to 4·5°K, while Cr, Mn and Fe reduce T_c strongly. D. SHOENBERG

537.312.62

7978. Effects of elastic deformations on superconductivity. I. The case of tin. C. GRENIER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 24, 2302–4 (*June* 13, 1955) In French.

The variation of the critical magnetic field under the influence of elastic deformations has been studied as function of temperature. The temperature dependence is similar to that of the isotropic effect, but there is a strong anisotropy as far as the absolute values are concerned. This anisotropy is linked with the elementary deformations in the three principal directions of the crystal. H. LONDON

537.312.62 : 536.631

7979. Heat capacities of vanadium and tantalum in the normal and superconducting phases. R. D. WORLEY, M. W. ZEMANSKY AND H. A. BOORSE. *Phys. Rev.*, **99**, *No.* 2, 447–58 (*July* 15, 1955).

The heat capacities of two samples of vanadium and two of tantalum have been measured in the normal and superconducting phases in the temperature interval between 1·7 and 5°K. Below the transition temperature T_0, the superconducting heat capacity of both metals could be represented accurately by the relation $C_s = AT + BT^2$. In the normal phase the data obeyed the usual relation $C_n = \gamma T + (464/\theta^3)T^3$. From these data H *v.* T curves were calculated and values of H_0, the threshold field at absolute zero, were obtained. For the better vanadium sample the values of the various constants were found to be $T_0 = 4{\cdot}89$°K, $A = -1{\cdot}97\times10^{-3}$ cal/mole. deg.^{2}, $B = 1{\cdot}69\times10^{-3}$ cal/mole. deg.^{3}, $\gamma = 21{\cdot}1\times10^{-4}$ cal/mole. deg.^{2}, $\Theta = 273$°K, and $H_0 = 1\,340$ oersteds; for the better tantalum sample $T_0 = 4{\cdot}38$°K, $A = -1{\cdot}45\times10^{-3}$ cal/mole. deg.^{2}, $B = 1{\cdot}33\times10^{-3}$ cal/mole. deg.^{3}, $\gamma = 13{\cdot}0\times10^{-4}$ cal/mole. deg.^{2}, $\Theta = 231$°K and $H_0 = 860$ gauss. The measured heat capacities were compared with the predictions of the Koppe theory and the α-model. A.

537.312.62 : 621.317.32.027.21 : 621.375.2.024

7980. A superconducting modulator. I. M. TEMPLETON. *J. sci. Instrum.*, **32**, *No.* 8, 314–15 (*Aug.*, 1955).

A new type of d.c. amplifier for use at liquid helium temperatures, based on a magnetically modulated tantalum wire, is described. The input impedance is approximately $10^{-3}\,\Omega$ and noise figures down to approximately 2×10^{-11} V are fairly easily obtained. The application of this instrument as a null detector for the measurement of very small voltages in a liquid helium bath is described. A.

537.312.9

7981. Effect of pressure on the electrical properties of indium antimonide. D. LONG. *Phys. Rev.*, **99**, *No.* 2, 388–90 (*July* 15, 1955).

The electrical resistivity and Hall coefficient of indium antimonide have been measured as a function of pressure to 2000 atm at 0, 24·3 and 54·3°C. The sample was *p*-type at low temperatures and became intrinsic with respect to the type of conductivity-temperature variation at about 220°K. It was found that the resistivity and Hall coefficient both increase exponentially with pressure, but at different rates, the resistivity curves having the greater slopes. The experimental results indicate an increase in the energy gap of $14{\cdot}2\times10^{-6}$ eV/atm and a decrease in the electron mobility of 14% for 2000 atm pressure at room temperature. A.

537.32 : 539.4.016.2

7982. Thermoelectric power of cold-worked silver and gold wires at low temperatures. M. J. DRUYVESTEYN AND H. MENSEN. Letter in *Appl. sci. Res. B*, **4**, *No.* 5, 388–92 (1955).

Results of measurements of thermoelectric power of couples consisting of drawn and annealed gold and silver wires respectively. C. A. HOGARTH

537.36

7983. Experimental test of Overbeek and Wijga's theory. A. J. RUTGERS AND R. JANSSEN. *Trans Faraday Soc.*, **51**, *Pt* 6, 830–2 (*June*, 1955).

A system of two capillaries of different diameter can serve as a model of a porous plug, and can be used to test Overbeek and Wijga's theory with respect to the interpretation of electrokinetic measurements performed with porous plugs. Experiments completely confirm this theory. Measurements in porous plugs, with surface conductance negligible or finite, lead to the same conclusion. A.

537.363 : 541.64

7984. Electrophoresis of charged polymer molecules with partial free drainage. J. J. HERMANS AND H. FUJITA. *Proc. K. Ned. Akad. Wetensch. B*, **58**, *No.* 3, 182–7 (1955).

The theory of Brinkman and of Debye and Bueche is extended to polyelectrolyte molecules in salt solutions, subject to an electric force. The model used is a porous sphere in which the density of polymer segments, and therefore also that of the fixed charges, is constant. For the charge density due to mobile ions an expression is used which was derived for this model by Hermans and Overbeek on the assumption that the approximation of Debye and Hückel is applicable. Relaxation effects are not taken into account. The final result for the electrophoretic mobility is a function of two parameters: (1) the ratio β between the molecular radius and the thickness of the diffuse double layer, and (2) Debye's "shielding ratio" σ. When $\beta \gg 1$ and $\beta > \sigma$, the molecule is free-drained. When $\sigma \gg 1$ and $\sigma > \beta$, the result of the calculation is identical with that obtained by Henry for compact spheres. The effect of molecular weight on electrophoretic mobility is small as long as $\sigma < \beta$ and in most other cases will not be very pronounced. A.

ELECTRIC DISCHARGES 537.52

537.523.4 : 621.3.015.54

7985. Time-lag data for spark discharges in uniform field gaps. A. AKED, F. M. BRUCE AND D. J. TEDFORD. *Brit. J. appl. Phys.*, **6**, *No.* 7, 233–6 (*July*, 1955).

Formative time lags of spark breakdown have been measured for air in uniform fields with static applied voltages up to 63 kV; and the very long time lags ($>10^{-4}$sec) predicted by theory for such conditions have been recorded. Time lag data have also been obtained for air in uniform fields with impulse spark voltages up to 150 kV for standard impulse waveforms, and also for lower voltages with non-standard impulse waveforms. For the latter condition the data indicate an impulse ratio of the order of 1·01. Comparative data for sphere gaps are included. A.

537.523.5

7986. On the cathode and anode falls in high-current carbon arcs. G. MÜLLER AND W. FINKELNBURG. Letter in *Naturwissenschaften*, **42**, *No.* 10, 294–5 (1955) In German.

Describes probe measurements of potential distributions near the electrodes in carbon arcs carrying currents varying up to about 350A. Cathode falls were as low as 3 ± 2V. Similar low falls are reported for the anode region of the plasma. J. D. CRAGGS

537.523.5

7987. Analysis of electrode phenomena in the high current arc. J. D. COBINE AND E. E. BURGER. *J. appl. Phys.*, **26**, *No.* 7, 895–900 (*July*, 1955).

An analysis is made of the phenomena at the electrodes of a high-current short-time arc. It is shown that the input power density to the anode spot is in the range 5×10^4 to 1×10^6 watts/cm^2. To a first-order approximation, all this power can be carried off by evaporation. Power conducted into the metal and lost by radiation is negligible in the probable operating range. For most materials, the anode spot is probably considerably above the boiling temperature. The process of evaporation holds the spot temperature constant at a value such that the input power and evaporation power are equal. Experimental data indicate that for any given metal the anode spot temperature is that for which the evaporation power density is at least 3×10^5 watts/cm^2. As an example, for copper the theoretical limits of temperature are 2490 to 3040°K, while experimental data indicate at temperature of 2920°K. Other metals considered are: Ag, Al, C, Fe, Mo, Sn, Ti, W, Zn, Zr. It is also shown that for the maximum power input that can be expected at the cathode, the thermionic emission current density is very small compared to the observed values of current density. A.

537.525.3 : 537.525.72 : 537.525.8

7988. Role of "ageing" in the production of Joshi effect in mercury vapour. N. A. RAMAIAH AND H. C. GAUR. Note in *Naturwissenschaften*, **42**, *No.* 8, 207–8 (1955).

Describes the effects of various forms of wall treatment in ozonizer corona discharges in various gases at low pressures. J. D. CRAGGS

537.527.5

7989. Electrode [voltage] drops and arc gradients in high-pressure mercury discharges. P. GERTHSEN AND P. SCHULZ. *Z. Phys.*, **140**, *No.* 5, 510–23 (1955) In German.

Describes measurements of plasma voltage gradients and electrode drops in Hg arcs (pressures 3–30 atm) at 5–25 A. Data, i.e. anode drops + cathode drops are plotted. At 23 atm this total voltage is about 10·5, independent of current, whilst at 3 atm, 5 A, it is about 15·4 V falling to the current independent value of 10·5 V at about 16 A. Relaxation processes in the electrode drop regions are discussed in some detail, quantitatively. J. D. CRAGGS

537.529

7990. Electrical breakdown in germanium at low temperatures. F. J. DARNELL AND S. A. FRIEDBERG. Letter in *Phys. Rev.*, **98**, *No.* 6, 1860–1 (*June* 15, 1955).

The critical field for non-ohmic rise of conductivity leading to breakdown in fairly pure germanium specimens is measured at low temperatures. At 4·2°K this field increases with strength of a transverse magnetic field applied to the crystals and is marked in more crystals. A slight increase in critical field as the temperature is further lowered to 1°K is observed. G. F. J. GARLICK

537.529 : 621.3.015.5 : 621.317.39

7991. Determination of small gap widths used in breakdown studies by capacitance measurements. A. H. SHARBAUGH AND R. M. FUOSS. *Rev. sci. Instrum.*, **26**, *No.* 7, 657–9 (*July*, 1955).

The mutual capacitance between hemispherical electrodes which are separated by a distance less than one-tenth of their radii is found experimentally to vary

directly with the logarithm of the spacing. A mathematical derivation is presented which suggests that such a relation should hold. A particular electrode-dielectric assembly may be calibrated at large spacings where accurate mechanical measurements can be made, and then the capacitance increment corresponding to any desired smaller spacing may be obtained by a simple linear extrapolation. Electrode separations as small as 1μ have been determined to an accuracy of less than 5% with this technique. A.

X-RAYS 537.531

537.531 : 535.343

7992. The *L*-absorption spectra of gold in gold–silver alloys. C. MANDE. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 23, 2222–4 (*June* 6, 1955) In French.

Gives results of measurements on Au–Ag alloys containing 75 and 50% of gold by weight. The three L discontinuities are displaced towards shorter wavelengths from their position for pure gold. Two subsidiary maxima associated with the L_{III} discontinuity are displaced towards longer wavelengths from their position for pure gold. A. E. DE BARR

537.531 : 535.82

7993. Improved resolution with the X-ray projection microscope. W. C. NIXON. Letter in *Nature* [*London*] **175,** 1078–9 (*June*, 1955).

Using an X-ray target of beaten gold leaf $0{\cdot}1\mu$ thick, stretched over a 100μ aperture, a resolving power of $0{\cdot}1\mu$ is obtained with a 10 kV electron beam. Further improvement is considered possible using thinner targets and lower voltages. R. REED

537.531 : 539.166.08

Dosimetry of X- and γ-rays by alkali-halide crystals containing *U*-centres. *See Abstr.* 8220

537.531.08

7994. Measurement of instantaneous dosage rate from pulsed X-rays, by means of a scintillation counter. H. JAHN. *Z. angew. Phys.*, **7,** *No.* 7, 317–21 (1955) In German.

The generator gives 40–95 kV in pulses of 10^{-2}—5×10^{-6} sec duration. Series and parallel resistances are arranged in the X-ray tube circuit to allow connection of a cathode-ray oscillograph and the recording of current and voltage waveforms. Corresponding pulses of X-ray energy to a level of $3{\cdot}3\times10^{-8}$ r can be measured with a scintillation counter amplified to record on a cathode-ray oscillograph. Wavelength dependence in the response of the phosphors used is determined for the region 0·7 to 0·2 Å. Curves, circuits and cathode-ray traces are given. D. V. MABBS

537.531.08

7995. Automatic isodose recorder. M. BERMAN, J. LAUGHLIN, M. YONEMITSU AND S. VACIRCA. *Rev. sci. Instrum.*, **26,** *No.* 4, 328–33 (*April*, 1955).

An apparatus is described which compares the signals developed by two detectors. An application is the measurement and plotting of the distribution of radiation energy produced by X-ray generators. Measurement of the radiation energy is made with ionization chambers or scintillation counters as detectors, the signals of which are amplified with d.c. amplifiers. The noise level of the amplifiers is equivalent to a current of about 5×10^{-15} amperes when used with an input resistor of 10^{11} ohms. The ratio of the outputs of the two detectors is obtained directly, using a servo system which compares a fraction of the larger signal with the smaller one. The accuracy and reproducibility of the balancing circuit is better than 0·2%. The minimum detectable signal is less than 0·1 millivolt. The same servo system is also employed to control the motion in space of one of the detectors (a probe) so as to seek a position such that its signal is any preselected portion of the other detector's (monitor) signal. Thus, a path of constant energy is traversed by driving the probe perpendicularly to the direction of the X-ray beam and controlling the position parallel to the beam through the servo system. The trace of the path of the probe is simultaneously duplicated and recorded on a chart. The mechanical reproducibility of the detector position and plotting mechanism in any direction is better than one millimetre. The application of the apparatus for the automatic determination and recording of isodose contours produced in water by the absorption of X-ray beams of widely different energies is outlined. A.

537.531.08 : 621.386.82

7996. A sub-standard X-ray dosemeter. F. T. FARMER. *Brit. J. Radiol.*, **28,** 304–6 (*June*, 1955).

The instrument is designed for routine measurements in radiotherapy. It consists of a thimble chamber on the end of a polythene cable, and the charge dissipated is measured by a Townsend balance circuit, giving a dial reading in roentgens. A simple device compensates for valve drift during exposure, and the accuracy is within 1% over long periods. The instrument forms a convenient alternative to the Victoreen for standardization and other X-ray measurements. F. T. FARMER (R)

CATHODE RAYS . POSITIVE RAYS 537.533/.534

537.533

7997. The measurement of current impulses of free atomic charge carriers with the inductometer. E. BAGGE. Note in *Naturwissenschaften*, **42,** *No.* 5, 120 (1955) In German.

It was shown that current impulses from a betatron could be measured by observing the voltage impulse induced in a solenoid through which the beam passed. J. HUGHES

537.533

7998. Determining betatron energy by activity ratios. M. BIRNBAUM, E. M. HARTH, L. SEREN AND R. TOBIN. *Nucleonics*, **13,** *No.* 4, 64, 66 (*April*, 1955).

A useful energy calibration of betatrons at about 11 MeV is obtained by observing the ratio of Cu^{62} and Ag^{106} activities in irradiated copper and silver disks. This ratio is extremely sensitive to the peak bremsstrahlung energy in the region of 11 MeV and an accuracy of 10 keV is obtainable. L. R. SHEPHERD

537.533 : 537.534 : 621.384.62

7999. A cavity accelerator. J. POTTIER. Note in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 5, 949–52 (*May*, 1955) In French.

A brief description of a single cavity accelerator for producing 2–300 kV electrons, protons or deuterons. The re-entrant cavity is driven by a 50 Mc/s, pulsed, push-pull oscillator. Difficulties due to the multipactor effect were reduced by the introduction of an annular disk in the accelerating gap. Ion beam currents of 20 μA, having a narrow energy spectrum, can be obtained. E. A. ASH

537.533 : 621.3.018 : 621.384.612

8000. Betatron oscillations in the synchrotron. C. L. HAMMER, R. W. PIDD AND K. M. TERWILLIGER. *Rev. sci. Instrum.*, **26**, *No.* 6, 555–6 (*June*, 1955).

These have been investigated by excitation with a transverse electric field. The results indicate that the betatron oscillation is composed of a group of component frequencies which are separated by the frequency of synchrotron phase oscillation. The suggested explanation of the observed splitting is the modulation of the betatron oscillation frequency by the synchrotron oscillations. A.

537.533 : 621.318.2 : 621.384.6

8001. Alternating-gradient channel using permanent bar magnets. W. F. STUBBINS. *Rev. sci. Instrum.*, **26**, *No.* 7, 666–71 (*July*, 1955).

The channel, for containing relativistic electrons (7 MeV), is made by arranging sets of four permanent bar magnets along an evacuated tube. The resultant field from each set is calculated assuming point magnetic poles. Four configurations for the magnet sets are considered and the criteria for retaining and focusing the electron beam are established for each configuration by matrix analysis of the equations of motion of the electrons in the periodic magnetic fields. These equations relate the magnetic pole strengths, the set positions, and the electron energy ranges permissible for each case. The aperture of the configuration is indicated, and experimental results are given. A.

537.533 : 621.384.61

8002. Strong focusing for particle accelerators. W. DÄLLENBACH. *Z. angew. Phys.*, **7**, *No.* 7, 344–60 (1955) In German.

An expanded version of a previous publication [Abstr. 4713 (1955)]. E. A. ASH

537.533 : 621.384.611

8003. General purpose X-band laboratory microtron with facilities for electron extraction. H. F. KAISER AND W. T. MAYES. *Rev. sci. Instrum.*, **26**, *No.* 6, 565–7 (*June*, 1955).

A 3 MeV microtron particularly suited for laboratory use in nuclear and electron physics. About twelve electron orbits, in operating modes representing energy gains per turn up to 255 keV, may be obtained. By means of a magnetic shield probe, electrons may be extracted from any orbit for external experiments. Final average orbit currents of 10^{-7}A and X-ray yields of 0·5 r/min at 10 cm are obtained. Ellipsoidally shaped sealed-off glass microtron tubes are under development. A.

537.533 : 621.384.612

8004. Method for the prompt destruction of the electron beam in a synchrotron. I. C. L. HAMMER AND A. J. BUREAU. *Rev. sci. Instrum.*, **26**, *No.* 6, 594–8 (*June*, 1955).

By passing current through coils wrapped round a section of the vacuum chamber of a synchrotron it is possible to change the fall-off index of a part of the guide field while leaving the remaining guide field unaltered. This technique is used on the Iowa State College 70 MeV synchrotron, and complete beam destruction is found experimentally to occur in less than 0·08 μsec. The build-up of the radial oscillation is analysed, and it is estimated that complete destruction of the beam is accomplished in approximately 10 revolutions or 0·06 μsec. The analysis also shows that this technique can be a valuable aid in the extraction of an electron beam from a synchrotron or betatron. A.

537.533 : 621.384.612

8005. Method for the prompt destruction of the electron beam in a synchrotron. II. C. L. HAMMER AND A. J. BUREAU. *Rev. sci. Instrum.*, **26**, *No.* 6, 598–600 (*June*, 1955).

The analysis of the betatron oscillations of a two-sector synchrotron given in Pt I is generalized to apply to positions in the synchrotron other than the centre of the perturbed sector. In this manner the azimuthal position of the maximum radial displacement of the electrons is found. This analysis is used to find the optimum position of the internal target with respect to the perturbing coils. A.

537.533 : 621.385.833

8006. Power flow in electron beams. L. R. WALKER. *J. appl. Phys.*, **26**, *No.* 8, 1031–4 (*Aug.*, 1955).

The a.c. power flow in an electron beam moving in weak electric fields is given a precise definition. Since it is a quantity quadratic in the applied field strength its evaluation requires the quadratic perturbation theory of the beam to be worked out. Quadratic expressions in the first-order variables of the beam and circuit may also be written down which have the dimensions of power and are shown to satisfy a conservation theorem. The relations between the exact quantities of the non-linear theory and the constructs from linear theory are discussed. A.

537.533.1

8007. Second-order aberrations in sector shaped electromagnetic analyzers. H. G. VOORHIES. *Rev. sci. Instrum.*, **26**, *No.* 7, 716–17 (*July*, 1955).

The expressions for the second-order velocity aberration and the second-order angle-velocity aberration are given for a sector-shaped analyser with superimposed electric and magnetic fields. Focusing is in one plane. A.

537.533.2

8008. Electron liberation by low energy ions at metal surfaces and in gases. H. FETZ. *Brit. J. appl. Phys.*, **6**, *No.* 8, 288–91 (*Aug.*, 1955).

Two methods are described for the production of electrons by the impact of slow moving ions with metallic surfaces as well as gas molecules of the same type. In the first method, which is the simpler of the

two, a steady d.c. discharge provides the ion source but corrections are necessary for the effects of ultra-violet light. The second method, which uses a more complicated impulse technique, enables the electron emissions due to photons and positive ions to be measured separately. The experiments have shown that with copper surfaces, cleaned by reduction, the impact of nitrogen and argon ions give yields up to 1%, whilst for hydrogen and oxygen ions the yield is below 10^{-6}. When the kinetic energy E/p is increased beyond approximately a few 100 V/cm mm of mercury, ionization by collision of the gas atoms with the positive ions is noticeable for all gases examined. This indicates that for volume ionization by ion impact, a minimum energy of twice the ionization energy is required. A.

537.533.33

8009. Electron optics. I. Electron lenses. P. GRIVET, M. Y. BERNARD AND A. SEPTIER. *Paris: Bordas* (1955) 184 *pp.* In French.

This monograph in the series *Bibliotheque de la Science Moderne* deals with the properties of electron lenses. Most of the ten chapters comprise an up-to-date review of the methods for obtaining lens focal properties and aberration, particularly the mathematical methods. A limited amount of design data is given in illustration. Electrostatic lenses are dealt with in a more detailed manner than magnetic. Much of the most recent work on the latter is not adequately covered. M. E. HAINE

537.533.335

8010. Measurement of the induction and its derivatives in the plane of symmetry of magnetic cylinder lenses. P. GAUTIER. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 24, 2294–6 (*June* 15, 1955) In French.

It was earlier shown [Abstr. 5562 (1953), 2856 (1955)] that in rotationally symmetric magnetic lenses the axial values of the induction and its derivatives could be determined by means of mobile search coils. This paper shows that the same coils may be used without modification to measure the corresponding quantities in "cylindrical" magnetic lenses.

A.E.I. RESEARCH LABORATORY

537.533.35

8011. Experiments with an intermediate lens in a Siemens electron microscope of the old type. W. LIPPERT. *Optik*, **12,** *No.* 6, 274–80 (1955) In German.

Describes the modification of one of the old type Siemens electron microscopes, to take a simple wide bore intermediate lens. This extends the magnification range of the instrument and makes it possible to image the back focal plane of the objective in order to project the diffraction pattern of a transmission specimen. A.E.I. RESEARCH LABORATORY

537.533.35

8012. Beta-ray spectrometer for coincidence measurements. R. T. NICHOLS, A. V. POHM, J. H. TALBOY, JR AND E. N. JENSEN. *Rev. sci. Instrum.*, **26,** *No.* 6, 580–3 (*June*, 1955).

An intermediate image beta-ray spectrometer has been constructed utilizing the focusing properties of a U-shaped magnetic field distribution. The construction and performance of the instrument are discussed. A transmission of 5% has been attained with a resolution of 5·5%. A scintillation spectrometer is used in conjunction with the intermediate image spectrometer for the purpose of making coincidence measurements. A.

537.533.35

8013. Intermediate image focusing in coincidence beta-ray spectrometers. H. SLÄTIS AND C. J. HERRLANDER. Letter in *Rev. sci. Instrum.*, **26,** *No.* 6, 613–14 (*June*, 1955).

A method is described of using two β-ray spectrometers to give high transmission and resolution in coincidence measurements. The spectrometers utilize the intermediate image focusing principle. The form of the iron yoke normally used in such instruments has been modified to make it possible to have the source outside the yoke, the measurements show that interaction between the fields of the two spectrometers is negligible. Preliminary experiments give a resolution of 2·7% when the transmission is 5·7%.

D. R. CHICK

537.533.7 : 539.217

8014. On the transmission of slow electrons through metal foils. W. BERGER. *Ann. Phys.* [*Leipzig*] **15,** *No.* 7–8, 394–405 (1955) In German.

The transmission of slow electrons of 0–200 eV through chemically deposited Ag foils, 600–1000 Å thick, varies with the thickness d as e^{-ad}, where $a = 6{\cdot}5\times10^{5}\,\mathrm{cm}^{-1}$, independent of electron velocity. Electron microscopic observation indicated that the electrons did not pass through a homogeneous foil, but through holes of about 1000 Å diameter, which were uniformly distributed throughout the foil.

J. FRANKS

537.533.74

8015. On the scattering of high energy electrons. G. N. FOWLER. *Proc. Phys. Soc. A*, **68,** *Pt* 7, 559–64 (*July*, 1955).

The effect of the finite nuclear size on the scattering of high energy electrons depends upon the ratio of the small to the large radial Dirac function inside the nuclear charge distribution. An approximate expression for this ratio is given, valid for energies of the order of 150 MeV. The result is used to discuss the model independence of the scattering for the case of uniform and shell charge distributions. A.

537.533.74

8016. Distribution of electrons scattered by gold. L. MARTON, J. A. SIMPSON AND T. F. MCCRAW. *Phys. Rev.*, **99,** *No.* 2, 495–9 (*July* 15, 1955).

The distribution in energy and angle of 20-keV electrons scattered by gold has been measured. The energy resolution is better than 0·1% and the angular resolution better than 10^{-3} radian. Data are presented for gold of different thickness and degree of crystal orientation and for grazing angle reflection. A.

537.533.75

8017. Energy loss distribution for minimum ionizing electrons in a pressure proportional counter. E. F. BRADLEY. Letter in *Proc. Phys. Soc. A*, **68,** *Pt* 6, 549–51 (*June*, 1955).

Minimum ionizing electrons were fired through proportional counters, filled to various pressures up

to 10 atm, in order to test the validity of Landau's theoretical energy-loss distribution for fast particles passing through thin layers of matter. The experimental distributions were always wider than the theoretical one, although the discrepancy became smaller with increasing pressure. P. ROTHWELL

537.533.8

8018. The study by the method of electrical differentiation of the energy distribution functions of secondary electrons from a monocrystal of copper covered with a monocrystalline layer of cuprous oxide N. B. GORNYĬ. *Zh. éksper. teor. Fiz.*, **27**, *No.* 2(8) 171–9 (1954) In Russian.

Using the method previously described [Abstr. 1905 (1955)] the energy distribution functions are found for the (111) plane. The results are given graphically. J. HUGHES

537.533.8

8019. On bremsstrahlung in the non-relativistic region. R. K. BHATTACHARYYA. *Indian J. theor. Phys.*, **2**, *No.* 3, 111–20 (*Nov.*, 1954).

The differential cross-section for bremsstrahlung in the non-relativistic region is usually obtained from Bethe–Heitler's relativistic expression by making non-relativistic approximation. In the present paper the non-relativistic differential cross-section is obtained in a perfectly straightforward manner by using the non-relativistic Hamiltonian for an electron. A.

537.533.8

8020. Time dispersion of secondary electron emission. E. W. ERNST AND H. VONFOERSTER. Letter in *J. appl. Phys.*, **26**, *No.* 6, 781–2 (*June*, 1955).

For background see [Abstr. 9302 (1954)]. The method described is extended to the measurement of time dispersion of secondary emission. The upper limit of time dispersion for pure metals is found to be 6×10^{-12} sec which is an order of magnitude less than any previous direct measurement. A. H. W. BECK

537.533.8

8021. *Z*-dependence of bremsstrahlung. W. C. BARBER, A. I. BERMAN, K. L. BROWN AND W. D. GEORGE. *Phys. Rev.*, **99**, *No.* 1, 59–61 (*July* 1, 1955).

The relative amounts of bremsstrahlung produced by the elements Cu, Ta, Pb and U for incident electrons of energy 24 and 34 MeV were measured by using the $Cu^{63}(\gamma,n)Cu^{62}$ reaction as the photon detector. Because of the shape of the cross-section function, photons were detected in a comparatively narrow energy band centred at 17·5 MeV. The electron beam was monitored by a Faraday cup placed immediately behind the radiator and detector foils. Corrections were applied to account for ionization and radiation losses of the electrons, and for pair production and Compton losses of the photons. The experimentally-determined "thin-target" cross-sections relative to copper for Ta, Pb and U, respectively, were $5\cdot681\pm0\cdot13$, $6\cdot959\pm0\cdot16$ and $8\cdot221\pm0\cdot19$ per atom, at 24 MeV; and $5\cdot583\pm0\cdot08$, $6\cdot770\pm0\cdot09$ and $8\cdot172\pm0\cdot12$ at 34 MeV. These values are from 5–13% lower than the corresponding ratios calculated from the Bethe–Heitler theory (including screening and radiation produced in collision with atomic electrons). The results are consistent with a deviation from theory of $(1\cdot54\pm0\cdot2)\times10^{-3}Z^2\%$ for 24-MeV electrons, and $(1\cdot38\pm0\cdot14)\times10^{-3}Z^2\%$ for 34-MeV electrons. A.

537.533.9 : 537.534.9

8022. Čerenkov radiation and its applications. J. V. JELLEY. *Brit. J. appl. Phys.*, **6**, *No.* 7, 227–32 (*July*, 1955).

After a brief review of the original discovery of the radiation and the physical principles of the process that gives rise to it an elementary account is given of the theory of the effect. A general survey of the practical applications to cosmic-ray and high-energy physics is presented, with two examples of modern detectors discussed in greater detail. The article concludes with an account of recent experiments carried out on light pulses from the night-sky associated with cosmic-ray showers, found to be due to Cherenkov radiation in the atmosphere. A.

537.534

8023. A helical waveguide to accelerate protons from 1 MeV to 10 MeV. R. SERVRANCKX. *Bull. Acad. Roy. Belgique Cl. Sci.*, **41**, *No.* 4, 474–85 (1955) In French.

A description is given of the phase motion of protons in a helical waveguide of the type described in a previous paper [Abstr. 8356 (1954)]. The effects of losses and the pitch of the helix are considered. A. J. EGGINTON

537.534

8024. The synchrotron and its problems. E. PERSICO. *J. Phys. Radium*, **16**, *No.* 5, 360–5 (*May*, 1955) In French.

A non-technical account of the main principles, with a brief description of "strong-focusing." J. S. BELL

537.534

8025. The inelastic scattering of particles accelerated in a synchrotron. J. SEIDEN AND F. LURCAT. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2067–9 (*May* 23, 1955) In French.

A calculation of the amplitude of synchrotron oscillations set up by inelastic scattering from residual gas. J. J. WILKINS

537.534

8026. Differential *p–p* scattering cross sections at 410 MeV. J. MARSHALL, L. MARSHALL AND V. A. NEDZEL. Letter in *Phys. Rev.*, **98**, *No.* 5, 1513–14 (*June* 1, 1955).

Cross-sections (previously measured) have been corrected for the spin polarization of the scattered cyclotron beam. D. R. CHICK

537.534 : 548.7

8027. Crystal technique for measuring cyclotron beam energies. C. J. DELBECQ, W. J. RAMLER, S. R. ROCKLIN AND P. H. YUSTER. *Rev. sci. Instrum.*, **26**, *No.* 6, 543–6 (*June*, 1955).

A lithium fluoride crystal when irradiated with deuterons from a cyclotron develops a yellow colour; if the deuterons are stopped within the crystal, there is a sharp demarcation in colour between the irradiated and unirradiated portions. It has been found

that the measurement of the depth of penetration of the colour into lithium fluoride can be used to determine accurately (± 0·1 MeV at 20 MeV, ±0·2 MeV at 10 MeV) and rapidly the energy of deuterons in a cyclotron beam. A single exposure of a crystal to the deuteron beam allows one to determine not only the energy of the deuterons but also the angular orientation of the beam trajectories. A.

537.534 : 621.384.611 : 621.316.728

8028. Energy control for external cyclotron beams. G. SCHRANK. *Rev. sci. Instrum.*, **26**, *No.* 7, 677–80 (*July*, 1955).

A device is described which stabilizes the mean energy of the external beam from an FM cyclotron to better than 0·1%. This control is achieved by inspecting the end of the range of a sample of scattered particles, and then using this information to regulate the cyclotron magnet current. It is also used as an absolute instrument to measure the mean energy to 0·3% at the same time. A.

537.534.3

8029. Line width and curvature in mass spectrography. E. DURAND. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1872–4 (*May* 9, 1955) In French.

Dynamics treated by expanding Lagrangian in Taylor series, to third-order terms. (*a*) Neglecting third-order terms, approximate solutions of equations of motion are obtained. (*b*) Retaining third-order terms, more accurate equations of motion are derived, solved by substitution of solutions (*a*) in the non-linear part. To this approximation, line broadening is proportional to the square on the initial angular divergence, and the lines are curved. The broadening due to line curvature is small. N. M. KING

537.534.3 : 539.155.2

8030. A π-type of mass spectrometer for isotope abundance measurements. P. V. KRISHNAMURTHY AND R. K. ASUNDI. *J. sci. industr. Res.*, **14B**, *No.* 5, 195–200 (*May*, 1955).

The instrument parts and circuiting of an all-metal π-type mass spectrometer for isotope abundance measurements in the range 1–100 are described. The demountable universal gas type of ion source employed facilitates easy replacement by furnace or filament type for solid samples. An adjustable exit slit enables the variation of the resolving power to suit the mass range under study. The whole instrument is compactly mounted on wheels and operates directly from 220 V a.c. mains. The performance and range of the instrument are illustrated by a mass spectrogram for carbon dioxide. Isotope components present to the extent of 1 part in 10 000 can be detected with the d.c. amplifier employed. A.

537.534.74

8031. Double scattering experiment with 96-MeV protons. K. STRAUCH. *Phys. Rev.*, **99**, *No.* 1, 150–4 (*July* 1, 1955).

By using 96-MeV protons, a double scattering experiment has been performed with a variety of targets and scattering angles. The observed values of the asymmetry e in the intensity of the second-scattered beam are small. For instance with carbon as a first and second scatterer, and scattering angles of 20° the observed value of $e = +3{\cdot}6 \pm 1{\cdot}6\%$. It is concluded that the polarization P decreases rapidly with decreasing energy below 130 MeV. A.

537.534.8

8032. Proton bremsstrahlung. S. D. DRELL AND K. HUANG. *Phys. Rev.*, **99**, *No.* 3, 686–91 (*Aug.* 1, 1955).

The cross-section for proton bremsstrahlung is calculated from Sommerfeld's work and expressed as the classical orbit result plus a first quantum correction. This correction is due to the energy loss of the proton to radiation. For 150 keV X-rays emitted at 90° to a beam of 2 MeV protons incident on a tin ($Z = 50$) target, this correction decreases the classical prediction by 25% and serves to establish theoretical agreement with experimental results of Mark, McClelland and Goodman. A.

DISCHARGE TUBES . COUNTERS 537.54

537.542

8033. Ion source with no auxiliary magnetic field, for mass spectrometry. D. D. GVOZDANOVIĆ. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **5**, 45–8 (*March*, 1955) In French.

Electrons emitted from a hot filament are suitably focused by a grid and a series of electrodes. In comparison with Nier-type sources, ion currents are twice as great, and hydrogen analysis experiments indicate that H_3 creation is reduced, due to shorter ion trajectories in the source. Measurements of D_2/H_2 ratio gave constant results for different total intensities; accuracy was ±4% compared with previous values. The main drawback is variation of behaviour with filament temperature. N. M. KING

537.542

8034. Influence of space charge on the potential distribution in mass spectrometer ion sources. W. M. BRUBAKER. *J. appl. Phys.*, **26**, *No.* 8, 1007–13 (*Aug.*, 1955).

The rôle of space charge as a factor influencing the potentials and potential gradients in a mass spectrometer ion source of the electron bombardment type is calculated. Planar equipotential surfaces are assumed, and the analysis then becomes that of a plane parallel positive ion diode. The "cathode" of the ion diode may be either emission-limited or space-charged-limited. The analysis considers the charge of the electrons in the ionizing sheet and the charge of the positive ions in the diode. At a critical gas pressure the influences of the positive and negative charges on the potential of the ionizing region are equal and opposite, for small ionizing current. This concept leads to a pressure normalization in terms of the critical pressure. For a given source geometry and electron bombarding energy one can construct universal curves which give the potentials and the potential gradients as a function of the normalized gas pressure and the ratio of the ionizing electron current density to the repeller voltage. Experimental data are in agreement with the predictions of the theory. A.

537.542 : 537.591

8035. The efficiency of self-quenching G.M.-counters for cosmic ray particles. E. Fenyves. *Acta phys. Hungar.*, **4**, *No.* 4, 363–74 (1955).

The efficiency obtained experimentally was previously found to be smaller than the value expected theoretically. It is shown here that this discrepancy is due to the method employed in the determination of the efficiency. Using dead-time shortening circuits and an apparatus which is sensitive only to the penetrating component of cosmic rays, the efficiency of self-quenching G.M. counters is found to be greater than 99·9% in good agreement with the value expected theoretically. A.

537.542

8036. Thin glass windows. A. Hemmendinger and A. P. Roensch. *Rev. sci. Instrum.*, **26**, *No.* 6, 562–3 (*June*, 1955).

The fabrication and properties of thin glass membranes are described. Foil thicknesses are a few tenths of a micron, corresponding to energy losses for 1 MeV protons of 10–20 keV. A.

537.542

8037. The saturation potential in ionization chambers. G. Imbò and P. Vittozzi. *Geofis. pura appl.*, **30**, *No.* 1, 113–29 (1955) In Italian.

Two methods for the determination of the saturation potential are given. The first gives the following relation between the saturation potential and the saturation fraction (the same in both cases, plane and cylindric): $V^2 = 5{\cdot}91 \times 10^{-10}(v^2/C^2)[q/(1-S)]$, where C and v are respectively the electrical capacitance and the volume of the chamber, V the saturation potential, q the number of ion pairs generated per unit time in unit volume, and S is the saturation fraction. The second method allows, by means of graphic integrations, the pattern of the saturation potential against the saturation fraction to be drawn by points, for a specific ionization chamber and a given value of factor q. The methods may be extended to any kind of ionization chambers, provided the law of variation of the field intensity within the chamber itself is known. A.

537.542

8038. Operation of a pulse ion chamber at 4·2°K. R. K. Abele, R. E. Zedler and L. D. Roberts. Note in *Rev. sci. Instrum.*, **26**, *No.* 5, 521 (*May*, 1955).

A pulse ion chamber filled with helium at 4 to 17 mm pressure has been operated at 4·2°K. The breakdown threshold of the chamber is about 230 volts. Close to this point pulses of maximum height 10–30 times noise level were obtained with α-particles from a thick uranium source, the observed rise time of the order of 1 μsec being probably due to the amplifier.

D. R. CHICK

537.542

8039. Theoretical study of the functioning of the last stage of a photomultiplier. P. Leuba. *J. Phys. Radium*, **16**, *No.* 4, 296–303 (*April*, 1955) In French.

An examination of the relation between the profile and duration of voltage impulses produced on the last dynode of a photomultiplier and the duration and intensity of fluorescence from an excited crystal [cf. Abstr. 7330 (1950)]. C. G. MORGAN

537.542

8040. A fast-neutron scintillation counter with tissue response. R. Skjöldebrand. *J. nuclear Energy*, **1**, *No.* 4, 299–305 (*June*, 1955).

A scintillation counter for fast neutrons has been constructed. It has a response for different neutron energies that approximately equals the tissue dose-energy function. It is non-directional, gives a fair counting rate even for neutron fluxes below the tolerance levels, and has good γ-discrimination properties. A.

537.542

8041. Early history of the scintillation counter. A. T. Krebs. *Science*, **122**, 17–18 (*July* 1, 1955).

537.542

8042. The "Hodoscope Chamber": a new instrument for nuclear research. M. Conversi and A. Gozzini. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 189–91 (*July*, 1955).

The instrument consists of a stack of thin glass tubes containing neon placed in an electric field of 10 kV/cm. An ionizing particle passing through the stack produces a glow discharge in each of the tubes it traverses and the trajectory of the particle can be photographed. Examples are given of photographs of single particles and of showers. H. ELLIOT

537.542 : 537.534.9

8043. Čerenkov counters with thin Lucite radiators. J. Linsley and N. Horwitz. *Rev. sci. Instrum.*, **26**, *No.* 6, 557–60 (*June*, 1955).

Cherenkov counters are described which have been used successfully in measurements of the flux of primary cosmic-ray α-particles. They consist of cylindrical Lucite radiators 2·5 cm thick viewed by end-window photomultipliers. Fast singly-charged particles that pass through the effective area in directions roughly parallel to the counter axis give pulse-height distributions with 35–45% relative width at half-maximum for effective areas up to 60 cm². An analysis of factors that influence the resolution of Cherenkov counters is given. A.

537.542 : 621.374.32

8044. New multichannel recording time-delay analyzer. P. G. Koontz, C. W. Johnstone, G. R. Keepin, Jr and J. D. Gallagher. *Rev. sci. Instrum.*, **26**, *No.* 6, 546–54 (*June*, 1955).

The analyser includes a wide flexible time base. Time channels of 0·001, 0·01, 0·1, 1, and 10 sec width are provided; these may be combined in progressive sequence or used individually for essentially an infinite number of channels. Provision is made for either photographic or electric recording. Data obtained with the new analyser agree with a conventional ten-channel time-delay analyser over the limited range of the latter. A simple procedure is given for checking correct operation of the system. A.

537.542 : 621.374.32

8045. A portable twenty-four channel kicksorter. G. F. von Dardel. *J. sci. Instrum.*, **32**, *No.* 8, 302–7 (*Aug.*, 1955).

A 24-channel kicksorter has been developed essentially on the principles of Wilkinson. The circuits

contain 25 valves and 8 relays. The whole instrument is easily portable and consists of two units, weighing 25 and 10 kg. Normal channel width is 2 V and the level of the bottom channel can be varied between 0 and 100 V. A simple stabilizing device is described which can be connected to the kicksorter for applications where a slow drift occurs. A.

537.542

8046. Thirty-six-atmosphere diffusion cloud chamber. J. B. Elliott, G. Maenchen, P. H. Moulthrop, L. O. Oswald, W. M. Powell and R. W. Wright. *Rev. sci. Instrum.*, **26**, *No.* 7, 696–7 (*July*, 1955).

A 36-atm diffusion cloud chamber has been constructed for use with the 184-in. cyclotron and with the bevatron. Minimum-ionizing particles leave dense, sharp tracks of good contrast with hydrogen filling at design pressure. In the operation described, one event is obtained every 15 min for a reaction cross-section of 30 mb for negative pions on hydrogen. Among the unique features of the chamber are (*a*) the high pressure; (*b*) the high magnetic field; (*c*) the simple unit preassembly of the chamber and the upper pole piece; (*d*) the distortion-free photography afforded by the small camera windows of good optical quality directly in front of the camera lenses and the absence of a large top glass near the sensitive region; (*e*) the thin window for collimated beams; (*f*) the supported cast Astrolite windows for illumination; and (*g*) the satisfactory sensitive layer obtained despite the large height-diameter ratio of the pressure vessel. A.

537.542

8047. Cloud chamber for precision measurements. W. B. Fretter and E. W. Friesen. *Rev. sci. Instrum.*, **26**, *No.* 7, 703–10 (*July*, 1955).

A cloud chamber has been constructed in which accurate measurements of ionization and momentum can be made simultaneously. The chamber has a useful volume of 18 in. by 12 in. by 5 in., contains helium, and is in a magnetic field of 7 500 gauss. Procedures have been developed to measure momentum and ionization and to determine the errors. Measurements on 40 protons indicate an average probable error of 7% for an individual measurement of mass by the comparison of ionization and momentum. A calibration technique is used for the determination of the minimum ionization for each case. A.

537.543 : 621.3.014 : 621.3.011.4 : 621.385.2/.5

8048. On the space-charge-limited current between nonsymmetrical electrodes. G. D. O'Neill. *J. appl. Phys.*, **26**, *No.* 8, 1034–41 (*Aug.*, 1955).

The validity of employing an equivalent symmetrical anode for expressing the space-charge-limited current between nonsymmetrical electrodes is examined. It is shown that when the equivalent anode is determined by the capacitance, the error in the expression for the current is usually quite small and its approximate magnitude may often be estimated. Exact expressions for the capacitance of some basic electrode arrangements are given, with a résumé of corrections required for interpretation of experimental data. A.

537.543 : 621.385.833

8049. Electrode shapes for a cylindrical electron beam. P. N. Daykin. *Brit. J. appl. Phys.*, **6**, *No.* 7, 248–50 (*July*, 1955).

The problem of obtaining the electrode shapes which will maintain a cylindrical beam of space-charge limited current reduces to the problem of solving Laplace's equation for the electrostatic potential outside the space-charge region, with the appropriate boundary conditions on the surface of the beam. A new approximate analytical solution of the Laplace equation has been obtained, and numerical tables have been developed for designing the electrode shapes. A plot of the electrode shapes, which is applicable to either hollow or solid beams, has been drawn up. The shape of the outside electrodes is the same for either type of beam, but the hollow beam requires an additional set of electrodes located inside the beam. The shape of the outside electrodes agrees fairly well with that obtained previously by Pierce, Harrison, and Kuo Chu Ho and Moon. A.

IONIZATION . THERMIONICS 537.56/.58

537.56 : 537.533

8050. On ionization and desorption through strong electric fields. F. Kirchner and H. Kirchner. *Z. Naturforsch.*, **10a**, *No.* 5, 394–400 (1955) In German.

A continuation of previous work [Abstr. 9336 (1954)] on the influence of contaminating surface layers on the intensity distribution of field emission from a tungsten single crystal. Changes in intensity brought about by thin adsorbed layers are considered to be due to field ionization processes. C. G. Morgan

537.562

8051. Ion pair yields in the X-ray decomposition of hydrogen bromide in rare gas atmospheres. E. G. Zubler, W. H. Hamill and R. R. Williams, Jr. *J. chem. Phys.*, **23**, *No.* 7, 1263–7 (*July*, 1955).

The rate of X-ray induced decomposition of hydrogen bromide has been measured both in the pure gas and in rare gas atmospheres. The rate of ion pair formation under identical irradiation has been determined from the saturation ionization currents in rare gases and ion pair yields for decomposition of hydrogen bromide have been computed. Average yields were A-HBr, 4·7; Kr-HBr, 4·0; Xe-HBr, 4·7; HBr, 4·6; HBr-Xe, 5·2; where the first substance named is the major component. A mechanism for decomposition by ion formation accounts for a yield of 4·0. Values above this are attributed to dissociative excitation without ionization. A.

537.562

8052. Photoionization efficiencies and cross sections in O_2, N_2, CO_2, A, H_2O, H_2, and CH_4. N. Wainfan, W. C. Walker and G. L. Weissler. *Phys. Rev.*, **99**, *No.* 2, 542–9 (*July* 15, 1955).

The photoionization cross-sections of several gases were obtained by making simultaneous measurements of the total absorption cross-sections and ionization efficiencies in the wavelength region from 473 Å to 1 100 Å. In each case the total absorption cross-sections were in agreement with those reported by others. For O_2, the ionization cross-sections were found to be between 5 and 30×10^{-18} cm^2, while those for N_2 were close to 23×10^{-18} cm^2 over almost the

entire range studied. The ionization cross-section of argon at the onset of ionization was compared with the theoretical estimate made by Dalgarno. The long-wavelength limits for photoionization were determined and were found to yield ionization potentials in good agreement with those obtained by spectroscopic and electron impact methods. A.

537.562 : 539.181

8053. Electron loss cross sections for helium atoms passing through gases. S. KRASNER. *Phys. Rev.*, **99**, *No.* 2, 520–6 (*July* 15, 1955).

Neutral helium atoms having kinetic energies in the range 100 to 450 keV are passed through a gas cell in which there is an intense magnetic field. When a few microns pressure of gas is admitted to the cell, an attenuation of the transmitted beam takes place, due to collisions in which the helium atoms become ionized, and removed from the unidirectional beam by the magnetic field. The method will not distinguish between collisions in which one or both helium electrons are lost. The sum of the cross-sections for the two processes is measured, per atom of gas traversed. The cross-sections rise in a rather uniform manner as energy increases in this range. In units of 10^{-17} cm^2 per atom of gas traversed, the values at 100 and at 450 keV are: for air, $30{\cdot}2 \pm 0{\cdot}8$ and $43{\cdot}9 \pm 1{\cdot}5$; for hydrogen, $5{\cdot}8 \pm 0{\cdot}6$ and $12{\cdot}5 \pm 0{\cdot}8$; and for helium, $11{\cdot}6 \pm 0{\cdot}6$ and $16{\cdot}8 \pm 0{\cdot}4$. A.

537.564

8054. Inelastic heavy particle collisions involving the crossing of potential energy curves. III. Charge transfer from negative ions of atomic hydrogen to protons. D. R. BATES AND J. T. LEWIS. *Proc. Phys. Soc. A*, **68**, *Pt* 3, 173–80 (*March*, 1955).

For Pt II, see Abstr. 1013 (1955). The Landau–Zener formula for the transition probability arising from the pseudo-crossing of potential energy curves is applied to the processes $H^-(1s)^2 + H^+ \rightarrow H(1s) + H(2s \text{ or } p)$, $H^-(1s)^2 + H^+ \rightarrow H(1s) + H(3s, p \text{ or } d)$ and $H(1s) + H(3s, p \text{ or } d) \rightarrow H(1s) + H(2s \text{ or } p)$ allowance being made for the effect of the orbital degeneracy. Cross-sections and rate coefficients are given over a wide range of impact energies and temperatures. The calculations show that the electron transferred in slow encounters between H^- and H^+ ions falls mainly into the third quantum level. Recombination thus leads to the emission of the first Balmer line. The de-activation process studied is of interest in that it provides an illustration of a type of mechanism whereby electronic energy can readily be converted into translational energy in thermal collisions. A.

537.564

8055. Reinterpretation of electron impact experiments in CO, N_2, NO, and O_2. H. D. HAGSTRUM. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1178–9 (*June*, 1955).

Recently a new value for $EA(O)$ of $1{\cdot}45 \pm 0{\cdot}15$ eV has been suggested. Here is investigated to what extent this value permits reinterpretation of electron impact data in CO, NO, and O_2, which were formerly contradictory. Appearance potentials of the various ions were calculated and compared with experimental values. This results in satisfactory agreement except for processes yielding a positive ion and a neutral fragment. A. J. TAYLOR

537.564

8056. Ionic configuration interaction in some excited states of the hydrogen molecule. J. T. LEWIS. *Proc. Phys. Soc. A*, **68**, *Pt* 7, 632–6 (*July*, 1955).

Using the Rayleigh–Ritz variational method, the $^1\Sigma$ states of the hydrogen molecule arising from the [H(1*s*), H(2*s* or *p*)], [H^+, $H^-(1s)^2$] and [H(1*s*), H(3*s*, p or *d*)] configurations are investigated in the region of transition from ionic to homopolar character. Potential energy curves are given for these regions. It is shown that the admixture of configurations has a very considerable effect on the potential energy curves even at large nuclear separations. The ionic content is defined and calculated for [H(1*s*), H(3*s*, *p* or *d*)] states and is found to vary rapidly in the transition region. The bearing of this result on collision theory is discussed briefly. A.

537.565

8057. The application of a method using coaxial cylinders to new measurements of the mobility of gaseous ions with charges of the same sign. R. COCHET. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 25, 2387–8 (*June* 20, 1955) In French.

Describes a method in which probe measurements of fields in a tube of coaxial cylinder geometry enable ionic mobilities to be determined. Measurements were made in air for positive and negative ions (age about $10^{-3} - 10^{-2}$ sec). Traces of ozone affected the results. J. D. CRAGGS

537.583

8058. Surface treatment of core metal used for oxide-coated cathode. J. NAKAI AND S. NAKAMURA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 566–70 (*July*, 1955).

In the oxide cathode coated with alkaline earth metal oxide on a nickel sleeve, it is generally known that the active material contained in the core significantly influences the thermionic electron emission. That is, the active material produces excess Ba through the reduction of oxide. The produced excess Ba diffuses in the oxide and appears on the cathode surface so as to enhance its thermionic activity. On the other hand, however, the nickel sleeve is generally made by a drawing method. Because of severe mechanical processings and heat treatments, the surface of the sleeve is subject more or less to contamination. As long as this surface contamination exists, the diffusion of the active material to the sleeve surface is impeded, and this causes an inferior activity. A.

537.583 : 548.73 : 621.385.032.216

8059. Changes in the structure of oxide cathodes at high temperatures. H. P. ROOKSBY. *Brit. J. appl. Phys.*, **6**, *No.* 8, 272–6 (*Aug.*, 1955).

The effect of heat treatment on BaO and SrO thermionic cathodes was examined by X-ray diffraction methods. Crystal growth in these cathodes was studied by a simple microbeam technique. In the temperature range 900–1 150°C, crystallites of BaO between 2 and 5μ in size are normally developed. This size is considerably greater than had been estimated previously by X-ray line broadening methods. Similar sizes develop in SrO in the range 1 100–1 250°C. In both oxides a gradual decrease in the structure-cell dimensions takes place with increasing temperature

of heating in a vacuum. This change is attributed to a progressive increase in the numbers of defects in the lattice and, in the case of BaO, appears to correspond with the process of thermionic activation. A.

537.583 : 621.385.032.216

8060. Measurement of excess Ba in practical oxide coated cathodes. L. A. Wooten, G. E. Moore, and W. G. Guldner. *J. appl. Phys.*, **26**, *No.* 8, 937–43 (*Aug.*, 1955).

More than 300 cathodes of various designs were prepared, aged for periods up to 50 000 hours, tested thermionically, and then analysed chemically. A.

537.583 : 621.385.032.216

8061. Excess Ba content of practical oxide coated cathodes and thermionic emission. G. E. Moore, L. A. Wooten and J. Morrison. *J. appl. Phys.*, **26**, *No.* 8, 943–9 (*Aug.*, 1955).

See previous Abstract. Emission and Ba content are given on (*a*) 125 coated cathodes, (*b*) 15 coated filaments; H_2 evolution by 19 uncoated cathodes was also measured. For analysis, each was isolated from the remainder of its tube. Coatings varied in composition from pure SrO to pure BaO and in density from 1 to 5 mg/cm². Ba was also measured in cathode coatings removed from their support metal. Essentially all cathodes contained excess Ba, but no cathode structure gave any correlation between Ba content and emission. These experiments show the following: If excess Ba (or Sr) is important, the significant amounts are probably less than one atom of Ba in 10^6 molecules of (BaSr)O. Because essentially all cathodes, including some with extremely low emission, contained at least this amount, performance is believed to be seldom limited by excess Ba. The concentration of Ba (or Sr) was not affected by using pure BaO or SrO coatings or Pt supports, although each of these steps led to very low emission; the highest emissions were obtained by operating at relatively low temperature during life, but this retained no more Ba in the coat. A.

COSMIC RAYS 537.591

537.591.1

8062. Cosmic-ray intensity above the atmosphere at high latitudes. L. H. Meredith, J. A. Van Allen and M. B. Gottlieb. *Phys. Rev.*, **99**, *No.* 1, 198–209 (*July* 1, 1955).

The total charged particle cosmic-ray intensity above the atmosphere has been measured with thin walled Geiger counters (total effective stopping power of apparatus and residual atmosphere 0·5 g/cm² of aluminium) carried in balloon-launched rockets at geomagnetic latitudes 54·3° N, 62·1° N, 71·9° N, and 86·7° N. The respective values of unidirectional particle intensity averaged over the upper hemisphere are: $\bar{J}=0{\cdot}44\pm0{\cdot}01$, $\leqslant 0{\cdot}50\pm0{\cdot}05$, $\leqslant 0{\cdot}50\pm0{\cdot}05$, and $=0{\cdot}48\pm0{\cdot}01$ (cm² sec sterad)$^{-1}$. These results are consistent with the complete or nearly complete absence of primary cosmic rays having a magnetic rigidity less than $1{\cdot}7\times10^9$ V. A.

537.591.1

8063. Remarks on low-energy gamma-radiation at great depths. M. Miesowicz, L. Jurkiewicz and J. M. Massalski. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 152–4 (*July*, 1955).

The authors maintain that the γ-radiation observed by them at depths of 540 and 660 m.w.e. is due to local radioactivity and not to cosmic rays as suggested by some other workers [see Abstr. 3863 (1955)]. H. ELLIOT

537.591.1

8064. Low-energy gamma radiation at great depths. M. Ageno. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 160–1 (*July*, 1955) In Italian.

Points out that a remark in the paper by Ageno, Cortellessa and Querzoli [Abstr. 3863 (1955)] on the production mechanism of a spectrum of low energy γ-rays which they observed, has been misinterpreted by Miesowicz, Jurkiewicz and Massalski (preceding abstract) and that it was not intended to imply that there was a genetic connection between these γ-rays and the cosmic radiation. P. ROTHWELL

537.591.1 : 523.165 : 532.51 : 538.56

Hydromagnetic waves and the acceleration of cosmic rays. *See Abstr.* 7635

537.591.15

8065. On the zenithal effect of extensive air showers. D. Brini, O. Rimondi, U. Valdrè and I. Filosofo. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1269–72 (*June*, 1955).

The zenith angle dependence of shower frequency has been determined using counter trays placed at the vertices of an equilateral triangle of side 5·2 m. The angle of acceptance was defined by means of lead shields. Assuming a distribution of the form $f(\theta)=\cos^n\theta+B$ it is found that values of n from 4 to 7 fit the experimental data. H. ELLIOT

537.591.15

8066. The rates of penetrating showers at sea level. C. B. A. McCusker, J. G. Dardis and B. G. Wilson. *Proc. Phys. Soc. A*, **68**, *Pt* 7, 585–90 (*July*, 1955).

The times of arrival of 17 665 local and 2 526 extensive penetrating showers have been recorded. The showers penetrated various thicknesses of lead from 17·5 cm to 97·5 cm. A variation of the rate of local showers with solar time which is correlated with the small diurnal pressure variations appears to be statistically established. This variation seems to have a much larger barometric coefficient than that derived from the large pressure changes associated with the weather. No significant variation of the rate of local showers with sidereal time was found. Possible variations of the rates of penetrating extensive showers with solar and with sidereal time are discussed. A.

537.591.15 : 518.5

8067. Numerical calculations on the fluctuation problem in cascade theory. J. W. Gardner, H. Gellman and H. Messel. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 58–74 (*July*, 1955).

The problem of obtaining numerical results is discussed. Results, using the electronic computer, Ferut, and desk calculating machines are presented

for a "model-test-run" on the nucleon cascade in homogeneous nuclear matter. These are discussed in relation to an extensive programme of computations for the physically important case of electron-photon cascades. A.

537.591.5

8068. Changes in phase of the diurnal variation of the cosmic radiation over the years. R. STEINMAURER AND H. GHERI. Note in *Naturwissenschaften*, **42**, *No.* 10, 294 (1955) In German.

The diurnal variation of the cosmic-ray intensity on the Hafelekar has been investigated using ionization chamber data for which the records go back to 1932. The phase of the variation shows a gradual change over the years consistent with a 22 year cycle. H. ELLIOT

537.591.5

8069. On the solar and sidereal daily variations of Auger showers. P. AUGER, A. CACHON, A. DAUDIN, A. FRÉON AND C. MOSZKOWSKI. *C.R. Acad. Sci. [Paris]* **240**, No. 25, 2407–9 (*June* 20, 1955) In French.

Recent measurements on the time variations of air showers at the Pic du Midi confirm previous results which showed a variation of shower frequency over the sidereal day. The maximum shower frequency occurs when the Milky Way is overhead. H. ELLIOT

537.591.5

8070. On the positive temperature effect in the cosmic radiation. H. TREFALL. *Proc. Phys. Soc. A*, **68**, *Pt* 7, 625–31 (*July*, 1955).

The results of several underground measurements of the positive temperature effect are examined in order to obtain some information about the attenuation length of high-energy π-mesons in air. It is shown that this quantity can hardly be smaller than the attenuation length of the primary component. If this is so, competition between disintegration and nuclear capture of the π-mesons can account for but a very small part of the positive temperature effect which has been observed at sea level. A.

MAGNETISM 538

538.082 : 621.317.42.087

8071. A recording magnetic variometer. J. H. MEEK AND F. S. HECTOR. *Canad. J. Phys.*, **33**, *No.* 7, 364–8 (*July*, 1955).

The circuit and detecting head of an electronic recording magnetic variometer are described. The apparatus will give continuous and immediately observable values of variations of magnetic field as small as 10^{-5} oersted, if necessary. A.

538.114

8072. A note on superexchange interaction. J. YAMASHITA. Letter in *Progr. theor. Phys.*, **12**, *No.* 6, 808–9 (*Dec.*, 1954).

Quantities occurring in a previous formula [Abstr. 9748 (1954)] for the superexchange interaction of MnO are evaluated approximately. G. E. BROWN

538.221

8073. Magnetic properties of cobalt telluride. E. UCHIDA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 517–22 (*July*, 1955).

Measurements of the magnetization have been made over a range of temperatures between liquid air and 1150°c. The results of these measurements show that this compound, when stoichiometric, possesses a ferromagnetic character. The value of the saturation magnetization is 7·52 gauss per gram ($0{\cdot}25\mu_B$). Evidence was found of a magnetic transition with a sudden disappearance of ferromagnetism at about 1000°c. These characteristic magnetic properties are similar to those of MnAs studied by Guillaud. Increase in tellurium content decreases the saturation moment of this compound, and when x is equal to 1·20 the compound is no longer ferromagnetic but shows a feeble constant paramagnetism which is independent of temperature. A.

538.221

8074. Magnetic transformation in MnBi. R. R. HEIKES. *Phys. Rev.*, **99**, *No.* 2, 446–7 (*July* 15, 1955).

Manganese bismuth loses its spontaneous magnetization very sharply at 633°K. At the same temperature drastic changes occur in the lattice constants. Previous workers have interpreted both these phenomena as arising from a ferromagnetic-antiferromagnetic transition. The present work indicates that the phase existing above 633°K is actually a ferromagnetic one with a Curie temperature of about 470°K. A.

538.221 : 538.65

8075. Magnetostriction and magnetomechanical effects. E. W. LEE. *Rep. Progr. Phys.*, **18**, 184–229 (1955).

The energy of a ferromagnetic substance comprises three parts, the exchange, anisotropy and magnetostatic (demagnetizing) energies. These all vary with the state of strain of the substance and so it will deform spontaneously if the deformation reduces the total energy (equal to the sum of the magnetic energy and the elastic energy). This phenomenon is known as magnetostriction and the three magnetic energies respectively give rise to the volume magnetostriction, the linear magnetostriction and the form effect. The greater part of this report is taken up with the linear magnetostriction since this is the effect most easily and often observed. The formal theory as developed by Becker and others is given. The various attempts to calculate the magnetostriction constants in terms of interatomic forces are reviewed. The fact that the linear magnetostriction can interact with stress to give rise to an additional anisotropy is discussed, together with some consequences of this fact; also the volume magnetostriction and related topics which arise from the variation of the exchange energy with interatomic distance. The form effect which arises incidentally in the analysis of volume magnetostriction is treated more fully, and the only secondary effect of any importance, the ΔE effect, is also discussed. The final section describes such topics as magnetic strain analysis and the magnetostriction of ferrites and antiferromagnetics. Over 100 refs. A.

538.221 : 538.653

8076. Magnetic investigations of the orientation and amplitude distribution of the internal strains in plastically deformed metals. L. REIMER. *Z. angew. Phys.*, **7**, *No.* 7, 332–6 (1955) In German.

Measurements of the remanent magnetization of cubic nickel and iron specimens which have been deformed by tension or compression show that the remanence is anisotropic, due to the presence of uniaxial strains in the direction of original deformation. The remanence change due to tension of nickel wires which have been previously deformed may be interpreted by assuming a rectangular amplitude distribution of the internal strains, whose orientations deviate by angles of no more than 10° from the direction of original deformation. Measurements were also made on bent specimens for which a different internal strain distribution was observed.

E. P. WOHLFARTH

538.221 : 539.234

Preparation of thin magnetic films and their properties. *See Abstr.* 8311

538.221 : 539.32

8077. Magneto-elasticity of polycrystalline iron and nickel. V. NARASIMHAN. *Indian J. Phys.*, **29**, *No.* 1, 27–37 (*Jan.*, 1955).

Some of the experiments for the determination of changes in the elastic moduli of polycrystalline iron and nickel are described. The results are compared with those derived from Akulov's theory of the ΔE effect in ferromagnetics. A.

538.222

8078. Mean magnetic susceptibility of the cobalt oxide CoO and the solid solutions 90 CoO–10 NiO and 91·7 CoO–8·3 CuO. H. BIZETTE AND B. TSAÏ. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 23, 2213–15 (*June* 6, 1955) In French.

Gives results of measurements between 20 and 350°K. Susceptibility maxima were observed at 290, 311 and 285°K respectively. For specimens cooled in a magnetic field of strength $2{\cdot}45\times10^4$ oersted from above these temperatures the susceptibilities were found to be temperature independent below these temperatures, the magnetic field being maintained during the measurements. E. P. WOHLFARTH

538.222

8079. Thermomagnetic investigation of a very pure specimen of thulium sesquioxide [Tm_2O_3]. N. PERAKIS AND A. SERRES. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 23, 2215–17 (*June* 6, 1955) In French.

Gives results of susceptibility measurements between 82 and 978°K. After correction for core diamagnetism the results obey the Curie–Weiss law with $p_B = 7{\cdot}56$, $\theta = -25$°K for the ion Tm^{+++}.

E. P. WOHLFARTH

538.222

8080. Magnetic susceptibility of indium antimonide. D. K. STEVENS AND J. H. CRAWFORD, JR. *Phys. Rev.*, **99**, *No.* 2, 487–8 (*July* 15, 1955).

The magnetic susceptibility of both *n*- and *p*-type InSb has been measured by the Faraday method from 65 to 650°K. The carrier contribution has been obtained by subtracting the lattice component in both the intrinsic range and the extrinsic range. These data indicate that the energy gap at 0°K is 0·262 eV and that the electron effective mass is $0{\cdot}028\,m_0$. The hole contribution to the susceptibility in the extrinsic range for the *p*-type specimen used was too small to permit a determination of the effective mass of holes. A.

538.222

8081. Magnetic susceptibility of α manganese at low temperatures. A. ARROTT, B. R. COLES AND J. E. GOLDMAN. Letter in *Phys. Rev.*, **98**, *No.* 6, 1864–5 (*June* 15, 1955).

Gives results of measurements on two samples, one from a cast ingot, the other a packed capsule of electrolytic flakes, between 1·8°K and room temp. The room temp. values of the mass susceptibility are 8·8 and $10{\cdot}6\times10^{-6}$ respectively. Below 100°K the cast sample shows an increasing susceptibility with decreasing temperature, leading to weak ferromagnetism at He temperatures. This is ascribed to the presence of interstitial gaseous impurities and may be almost completely suppressed by degassing, after which the susceptibility remains almost constant over the range of temperatures covered. E. P. WOHLFARTH

538.222

8082. Atomic phosphorus paramagnetic resonance experiment employing universal dissociator. H. G. DEHMELT. *Phys. Rev.*, **99**, *No.* 2, 527–31 (*July* 15, 1955).

A simple spectrometer for the observation of paramagnetic resonance of free atoms near 9 000 Mc/s is described. This is followed by a detailed discussion of a new dissociation technique employing a carrier gas and a high-temperature arc which is shown to be effective enough to allow oscilloscopic observation of the atomic nitrogen spectrum, previously reported by Heald and Beringer. This dissociation technique, which is believed to have universal applicability, has been used to produce atomic phosphorus. The spectrum due to its $^4S_{\frac{3}{2}}$ ground state has been observed. It consists of a narrow doublet which arises from magnetic h.f.s. interaction due to the P^{31} nucleus. The separation has been measured as $\delta\nu(P^{31}, {}^4S_{\frac{3}{2}}) = 56{\cdot}2 \pm 1{\cdot}5$ Mc/s, and the g_J factor for the ground state has been obtained as $g_J(P, {}^4S_{\frac{3}{2}}) = 2{\cdot}001\,9 \pm 0{\cdot}000\,4$, which is only slightly smaller than the free-electron g value. The occurrence of a h.f.s. in the supposedly symmetric $^4S_{\frac{3}{2}}$ ground state as well as the small g_J factor indicate the presence of higher state admixtures. The effects of beginning *jj* coupling in group V elements are briefly discussed and a sizeable electric quadrupole term in the ground-state h.f.s. of Sb and Bi is predicted. A.

538.222 : 538.614

8083. Study of the Faraday effect of anhydrous and hydrated paramagnetic salts at 3 kMc/s. J. SOUTIF-GUICHERD. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 22, 2126–8 (*June* 1, 1955) In French.

Describes the apparatus (sensitivity 12′) and gives results for copper and manganese sulphates in fields between about 500 and 1 500 oersted. An inversion was observed at about 1 000 oersted. E. P. WOHLFARTH

538.24 : 536.48

8084. Demagnetization experiments on cerium ethyl sulphate. A. H. COOKE, S. WHITLEY AND W. P. WOLF. *Proc. Phys. Soc. B*, **68**, *Pt* 7, 415–21 (*July*, 1955).

At temperatures below 1°K the magnetic suscepti-

bility of cerium ethyl sulphate is highly anisotropic, the molar Curie constant being 1·35 parallel to the crystal axis and less than 0·01 perpendicular to the axis. Demagnetization experiments using fields along the axis show that the magnetic susceptibility in this direction passes through a maximum at low temperatures, and that the specific heat is too large to be accounted for by magnetic dipole interaction between the magnetic ions. This behaviour is attributed to antiferromagnetic coupling of the ions, possibly due to the atomic electric quadrupole–quadrupole coupling suggested by Finkelstein and Mencher [Abstr. 3502 (1953)]. It is shown that after demagnetization to a low temperature it is possible to apply a magnetic field in a direction of low susceptibility without greatly raising the temperature, so that magnetic measurements can be made below 1°K. This technique has been applied to the determination of the critical fields of superconducting zinc and lead at temperatures below 1°K. A.

538.245

8085. Magnetostatics with ferromagnetics. V. I. Skobelkin and R. N. Solomko. *Zh. éksper. teor. Fiz.*, **28**, *No.* 4, 385–93 (1955) In Russian.

The variational principle of magnetostatics with ferromagnetics in the field of electric currents is formulated, leading to a solution of the general problem which could not be obtained by integration of Maxwell's equations owing to the non-linear relation between B and H. A system of axial symmetry is first considered, and then a planar system. The authors then derive the "complete δ-system" of functions and introduce direct methods of determining the magnetic flux. ELECTRICAL RESEARCH ASSOCIATION

538.245

8086. The dependence of the spontaneous magnetization on the magnetic field at low temperatures. L. Valenta. *Czech. J. Phys.*, **5**, *No.* 2, 171–7 (*April*, 1955).

Deals with a generalization of the Bloch–Møller three-half power law to the case of the dependence of spontaneous magnetization on the temperature and the magnetic field strength at low temperatures for a simple cubic lattice. It is shown that the derivation of the relations also admits such values of H and T for which the somewhat more general law given by Holstein and Primakoff fails. A.

ELECTROMAGNETISM . ELECTRODYNAMICS 538.3/.5

538.3 : 530.145

On the angular momentum of the electromagnetic field. *See Abstr.* 7691

ELECTROMAGNETIC WAVES AND OSCILLATORS 538.56

538.56 : 532.5

8087. On particular alternating fields in magnetohydrodynamics. R. Nardini. *Atti Accad. Sci. Torino I*, **89**, 17–36 (1954–55) In Italian.

In the special problem considered, solutions are not calculated using only one co-ordinate and the time, but rather the corresponding energy and average velocity. The result agrees with that obtained for the phase velocity; the group velocity and that of the wave front can then be calculated. A. BEER

538.56 : 532.5

8088. Magnetohydrodynamic oscillations in a rotating ellipsoidal liquid mass of cosmic dimensions. C. Agostinelli. *Atti Accad. Sci. Torino I*, **89**, 41–58 (1954–55) In Italian.

Magnetohydrodynamic oscillations are studied in a homogenous ellipsoidally shaped liquid, which is electrically conducting and rotating uniformly, being under the influence of gravitation and a uniform axial magnetic field, to which is added another field in the direction of the velocity of the liquid particles. A. BEER

538.56 : 532.5

8089. Magnetohydrodynamic oscillations in a liquid cosmic mass, uniformly rotating within an axial and an equatorial magnetic field. C. Agostinelli. *Atti Accad. Sci. Torino I*, **89**, 68–92 (1954–55) In Italian.

See preceding abstract. A study is made of a rotating liquid, being homogenous and electrically conducting, which is subject to the laws of gravitation and under the influence of two magnetic fields: one orientated along the axis of rotation, the other perpendicular to it. The importance of this case lies in the understanding of magnetohydrodynamic oscillations of the sun, involving the axial field and the intense fields supplied by the sunspots. A. BEER

538.56 : 532.5

8090. Remarks on an energy relation in magnetohydrodynamics. R. Nardini. *R.C. Accad. Naz. Lincei*, **18**, *No.* 4, 376–7 (*April*, 1955) In Italian.

Assuming that fluid motion and electromagnetic field are independent, an expression is obtained for the rate of change of the total kinetic, internal and electric energy within a volume occupied by fluid. It is shown that the equation remains valid for magnetohydrodynamics. R. A. NEWING

538.56 : 537.591.1 : 532.51 : 523.165

Hydromagnetic waves and the acceleration of cosmic rays. *See Abstr.* 7635

538.561

8091. Longitudinal plasma oscillations. II. G. Ya. Myakishev and A. A. Luchina. *Zh. éksper. teor. Fiz.*, **28**, *No.* 1, 28–37 (1955) In Russian.

The theoretical results of Pt I [Abstr. 7205 (1955)] are used for considering various special cases. It is shown that when longitudinal oscillations are propagated in discharge tubes the ion movement has in the majority of cases to be considered. The values of the space period and of the damping decrement are found as functions of the discharge parameters. The special cases distinguished are those of high and low frequencies, isothermal and strongly non-isothermal plasmas and high electron drift velocities. The comprehensive discussion considers a fair amount of literature available and shows that the experimental results can be brought into satisfactory agreement with the theory. B. F. KRAUS

538.561 : 621.3.018 : 621.385.833

8092. Plasma oscillations in electron beams. K. G. HERNQVIST. *J. appl. Phys.*, **26**, *No.* 8, 1029–31 (*Aug.*, 1955).

Self-sustained ion and electron plasma oscillations have been observed simultaneously in an ion neutralized electron beam travelling in a transverse magnetic field. The observed frequencies of oscillation agree with the Langmuir–Tonks theory for plasma oscillations. Electron plasma oscillations occur when the electron plasma frequency equals the gyro frequency of a circular orbit in the magnetic field. A.

538.565 : 621.372.413

8093. Collapsed toroidal springs as contact elements in microwave cavities. C. L. ANDREWS. Letter in *J. appl. Phys.*, **26**, *No.* 6, 777–8 (*June*, 1955).

Cylindrical helical springs of stainless steel or beryllium copper with ends welded together to form toroids have been used as contacting elements. If the toroid is "collapsed" by rotating its inner circumference axially with respect to its outer circumference, the spring is very tolerant in the dimensions and eccentricity of the cylindrical surfaces between which it fits. Data are presented on the variation of radial pressure with thickness of collapsed spring.

W. T. BLACKBAND

538.566

8094. The diffraction of a dipole field by a perfectly conducting wedge. R. TEISSEYRE. *Bull. Acad. Polon. Sci. Cl.*3, **3**, *No.* 3, 157–62 (1955).

A method is given for solving the diffraction problem of an arbitrary electric or magnetic dipole by a perfectly conducting wedge of arbitrary opening angle. The method consists in a generalization and modification of Senior's method [Abstr. 7801 (1953)] wherein one starts from a plane-wave solution.

T. J. REY

538.566 : 538.612

8095. A direct measurement of the ellipticity in the Hertzian Cotton effect by a quarter-wave method. R. SERVANT, P. LOUDETTE AND A. CHARRU. *C. R. Acad. Sci.* [*Paris*] **240**, *No.* 20, 1978–80 (*May* 16, 1955) In French.

The ellipticity of the Hertzian Cotton effect is shown to be genuine and not simply a depolarization.

A. J. EGGINTON

538.566 : 621.396.11

8096. Diffraction of a slit cut in an ideally conducting circular disk. G. N. KOCHERZHEVSKIĬ. *Radiotekhnika*, **10**, *No.* 4, 48–55 (1955) In Russian.

Using an expansion in terms of spheroidal functions the E and H plane polar diagrams are calculated and compared, for one case, with an experimental result. The agreement is very good. At a given wavelength the respective diagrams do not change much in character for a change in disk size. S. C. DUNN

538.566 : 621.396.11

8097. Theoretical and experimental study of electromagnetic scattering by two identical conducting cylinders. R. V. ROW. *J. appl. Phys.*, **26**, *No.* 6, 666–76 (*June*, 1955).

The scattering of a cylindrical TEM wave by two parallel, identical conducting circular cylinders is developed as a special case of a theoretical analysis which treats the scattering by an arbitrary array of cylinders. Only the case with the incident E-vector parallel to the axes of the cylinders is considered, and attention is focused on the mutual effects present when the cylinder diameter and spacing are comparable to a wavelength. The approximations made in the theory are tested experimentally using 3 cm microwaves in a parallel plate region. Significant departures from the results of the independent scattering hypothesis as predicted by the theory have been confirmed experimentally. A.

538.566 : 621.396.11 : 621.396.67

8098. Microwave diffraction by apertures of various shapes. S. J. BUCHSBAUM, A. R. MILNE, D. C. HOGG, G. BEKEFI AND G. A. WOONTON. *J. appl. Phys.*, **26**, *No.* 6, 706–16 (*June*, 1955).

Experimental results of the near zone diffraction field of circular and elliptical apertures and of the infinite slit are presented. The investigations were made on apertures which were illuminated by a plane polarized electromagnetic wave and whose characteristic dimensions were varied over a considerable range with respect to the wavelength of the incident radiation. Most of the measurements are compared with predictions from recently published approximate theories and in a few cases with exact solutions. In general the agreement between theory and experiment is found to be satisfactory. Some of the discrepancies are discussed. A.

538.566

8099. Theory of circularly symmetric standing TM waves in terminated iris-loaded guides. C. C. GROSJEAN. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 11–26 (*July*, 1955).

An exact treatment is given for the problem of describing the possible resonance modes of the circularly symmetric TM type in a terminated iris-loaded guide with cylindrical symmetry, which is commonly used in experiments. The applied method based on matching the field components at the mouths of the corrugations is very similar to the one used previously for infinite waveguides. For the sake of generality, none of the usually accepted theorems about the field configurations have been introduced in the theory. On the contrary, they finally appear as consequences of the present calculations. After suitable combination the final equations can be grouped into systems which are directly comparable to the final system established for infinite guides. The possible resonance modes are deduced and the properties of the corresponding field configurations are discussed in detail. The modes obtained are also compared to those that can exist in another type of terminated guides, which can equally well be treated by this method. A.

538.566 : 621.372.8

8100. Note on the properties of two functions appearing in the theory of TM wave propagation through periodically iris-loaded guides. C. C. GROSJEAN. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1264–6 (*June*, 1955).

Re-examination of the problem of propagation of circularly symmetric TM-waves through infinite iris-loaded waveguides. The properties of two functions

$g_1(x)$ and $g_2(x)$ in the expression for $E_z(a_1 z)$ are considered, and the dependence of g_1 and g_2 on β_0, the propagation constant, is analysed. Z. F. WOJNER

538.566

8101. Multipoles and asymmetric Schelkunoff waves. I. FERRARI. *R.C. Accad. Naz. Lincei*, **18**, *No.* 3, 304–8 (*March*, 1955) In Italian.

Previous work [Abstr. 4820 (1955)] is extended to the case of waves not possessing axial symmetry. The angular dependence of the magnetic field is determined by the functions

$$T(\theta, \phi) = (-1)^m P^m_{n+1}(\cos\theta)(M \cos m\phi + N \sin m\phi),$$

and the case $m = 1$ is considered in the present note. It is shown that a wave of any order n may be generated by a combination of suitably orientated multipoles. R. A. NEWING

538.566.3

8102. Statistical mechanics of Lorentzian electron plasmas and their applications to the ionosphere. R. JANCEL AND T. KAHAN. *Physics of the ionosphere* [*Cambridge*] 365–73. See Abstr. 5763 (1955). In French.

The distribution function of electronic velocities in an anisotropic plasma (constant magnetic field) for non-Maxwellian states (very strong electric fields) is calculated from the Boltzmann transfer equations. Explicit expressions are obtained for the magneto-ionic conductivity, dielectric tensor, Hall effect coefficient, deviation of an electron beam and a generalization of the mobility equation of Langevin. The results are applied to the propagation of plane e.m. waves in an ionized gas, and using the authors' general theory all the classical results for refractive index, phase and group velocity, attenuation, polarization, etc., are found. G. M. BROWN

538.566.3

8103. Analysis of the coupling of ordinary and extraordinary electromagnetic waves in a Lorentzian plasma and its application to the ionosphere. R. JANCEL AND T. KAHAN. *Physics of the ionosphere* [*Cambridge*] 374–83. See Abstr. 5763 (1955). In French.

Application of results of authors' analysis (preceding abstract) to the propagation of e.m. waves and to the coupling of *o*- and *x*-waves in an ionized gas with varying electron density with height (inhomogeneous plasma) and in the presence of a magnetic field (anisotropic plasma). G. M. BROWN

538.566.3

8104. Measurement of the non-deviative absorption of radiowaves in the ionosphere. P. LEJAY, G. PILLET AND R. CHEZLEMAS. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 18, 1745–8 (*May* 2, 1955) In French.

Various objections are given to the classical method of measuring absorption from successive $1F$ and $2F$ echo amplitudes. After elimination of one magneto-ionic component direct recording of the mean echo amplitude (in dbs) over an interval determined by the time-constant of the receiver ($\sim$ a few tenths second) has therefore been employed. Results show considerable departures from theory, attributed to (i) ionospheric focusing and (ii) rapid variations of absorption. Attempts are made to discriminate between these two. Resultant median values of absorption for each hour over Dec. 1954–Jan. 1955 vary with solar zenith angle χ according as $\cos^{0\cdot3}\chi$. G. M. BROWN

MOLECULAR AND ATOMIC STRUCTURE 539.1

THEORY OF SOLID STATE 539.11

539.11

8105. Cohesive energy of noble metals. K. KAMBE. *Phys. Rev.*, **99**, *No.* 2, 419–22 (*July* 15, 1955).

The method, developed by Kuhn and Van Vleck, and later simplified and extended by Brooks, for calculating the cohesive energy of monovalent metals, is here further extended to include the effects of the deviation of the effective ion-core potential from pure hydrogenic form in the vicinity of the surface of the *s*-sphere. A formula is derived for calculating the logarithmic derivative of the wave-function at the surface of the *s*-sphere. From the logarithmic derivatives of the *s*- and *p*-functions the ground state energy and the Fermi energy can be evaluated. The method thus extended is applied to the calculation of the cohesive energy of the monovalent noble metals. For these metals, the repulsion between ion-cores is important. Combining the repulsive energy, which is calculated by Fuchs with a modified Thomas–Fermi method, with the energy of valence electrons calculated by the present method, the total cohesive energy of copper is obtained. Since there is no calculation of the repulsive energy for silver and gold, the ion cores are assumed to be rigid and the energies of the valence electrons at the observed lattice spacings are determined and considered as the approximate total energies. The cohesive energies calculated at the observed lattice spacings with the rigid ion-core assumption are 61·7 for Cu, 55·8 for Ag, and 49·2 for Au in comparison with the experimental values of 81·2, 68·0 and 92·0 respectively. Here the energy unit is kcal/mole. A.

539.11

8106. Spin resonance of impurity atoms in silicon. C. P. SLICHTER. *Phys. Rev.*, **99**, *No.* 2, 479–80 (*July* 15, 1955).

An explanation is proposed for the weak satellite lines observed in the microwave electron spin resonance of Group V impurity atoms in silicon. The satellites occur halfway between the main hyperfine lines. It is proposed that the satellites represent the resonance of pairs of impurities close enough together for their exchange interaction to be very large compared to the hyperfine coupling. Mathematical details are worked out. A.

MOLECULES 539.13

539.13

8107. London–van der Waals attraction between macroscopic objects. J. T. G. OVERBEEK AND M. J. SPARNAAY. *Disc. Faraday Soc.*, *No.* 18, 12–24 (1954).

In the first part of this paper a description is given

of an apparatus with which attractive forces between two flat glass plates have been measured. One of the glass plates was attached to a spring. The bending of this spring was directly proportional to the force between the glass plates and could be followed with an accuracy of 10–30 Å with the aid of an electrical capacity method. The distances between the glass plates were measured by means of Newton interference colours. A discussion of the errors is given. The force-distance relation found, an inverse third-power law, followed the London–Hamaker theory but the force constant was found to be about 40 times larger than predicted by their theory. In the second part an extension of London's harmonic oscillator is discussed, leading to deviations from additivity of London–van der Waals forces which might be helpful in the understanding of the experimental results. Two groups of atoms a large distance apart instead of two atoms are considered, and a weak interaction is assumed between atoms of each group. It then appears that the polarizability is no longer the determining quantity in the force between the atoms such as given by London, but that large deviations from additivity can occur in the attractive force, whereas the polarizability remains practically unaffected. A.

539.13

8108. On the theory of electronic spectra of condensed systems. A. E. GLAUBERMAN. *Dokl. Akad. Nauk SSSR*, **100**, *No.* 3, 449–52 (1955) In Russian.

The statistical exchange effect between the optical electron and surrounding particles (atoms, ions, molecules) in condensed systems without crystalline order is discussed. Bogolyubov's distribution functions are used with the assumption of radial symmetry for the binary functions. An expression is derived for the mean frequency shift in its dependence on temperature and density; agreement with the few experimental data seems fair. J. JACOBS

539.13 : 541.18.04

8109. Investigations of the forces of interaction of surfaces in different media and their application to the problem of colloid stability. B. V. DERJAGUIN, A. S. TITIJEVSKAIA, I. I. ABRICOSSOVA AND A. D. MALKINA. *Disc. Faraday Soc.*, *No.* 18, 24–41 (1954).

The symmetric case of two-sided (or free) films of dilute soap solutions formed between two bubbles pressed together is investigated. Equilibrium thicknesses of these films have been measured as a function of capillary pressure inside the bubbles counterbalanced by the film's "disjoining action." In this case, in contrast to that of wetting films, molecular forces may only counteract and diminish the effect of the repulsion of ionic atmospheres which creates the equilibrium disjoining action. The results obtained clearly demonstrate the existence of an equilibrium disjoining action arising from ionic atmosphere overlapping and are in quantitative accordance with the corresponding theory, under the condition of introducing the important correction for the thickness (about 40 Å) of polymolecular hydrate layers. To prove the existence and the gap-width dependence of the molecular attraction between two macroscopic bodies a new type of microbalance has been constructed. This microbalance owing to the use of negative feed-back coupling is especially suited for measurements of weak forces of extraordinarily great gradient in space that would destroy the stability of equilibrium position of any ordinary high-sensitivity balance. With its aid, direct measurements of molecular attraction between plane and spherical quartz and glass surfaces were made in air and *in vacuo*. After extreme care had been taken to remove all traces of surface electric charges and organic impurities, quite reproducible results were obtained. The force values are the same when measured in air and *in vacuo* and are proportional to the radius of curvature of the spherical surface in accordance with the formula for molecular interaction of macrobodies previously deduced. The measured force values are about 1–2 orders smaller than the values that result from the London–Hamaker formula. The last part of this report describes a new method using crossed fibres permitting the "modelling" of colloid particle interaction by means of experiments with macrobodies in a more quantitative and precise manner and with less scattering of results than in Buzag's method. A.

539.132

8110. Calculation of electrostatic binding energies in systems of isotropic ions. C. T. O'KONSKI. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1174–5 (*June*, 1955).

The contribution of the polarizabilities to the binding energies in systems involving isotropic ions is calculated. Quadrupoles and higher terms are neglected because of lack of information regarding the induced multipole moments. An equation is derived which is rigorously correct for non-polarizable particles and also for isotropic particles when the induced dipoles are included. A. J. TAYLOR

539.132

8111. Structure and calculation of the binding energy of gaseous alkali halide dimers. C. T. O'KONSKI AND W. I. HIGUCHI. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1175–6 (*June*, 1955).

The method described in the preceding abstract is applied to alkali halides. The field equations were derived and as an example numerical calculations were carried out on $(NaCl)_2$. For the reaction $2\,NaCl \rightarrow (NaCl)_2$, ΔE was found to be $-1{\cdot}86$ eV. Molecular constants found for the monomer agreed with experimental values. A. J. TAYLOR

539.132

8112. Quantum-mechanical properties of a one-dimensional system composed of hard spheres. R. J. RUBIN. *J. chem. Phys.*, **23**, *No.* 7, 1183–6 (*July*, 1955).

The stationary-state wave-function for a one-dimensional system of hard-sphere particles in a box is known to be a determinantal combination of single-particle wave-functions. The time-dependent wave-function corresponding to a certain class of initially prepared states is shown to be a determinantal combination of single particle time-dependent wave-functions. The motion of the centre of gravity of such a system of particles is especially simple. A.

539.132

8113. Calculated energy of A–O–A type molecules by Mulliken's magic formula. Y. AOKI. *J. Phys. Soc. Japan*, **10**, *No.* 7, 503–11 (*July*, 1955).

Mulliken's "magic formula" is applied to the calculation of the dissociation energies of molecules of

the type A–O–A. *s p* hybrid atomic orbitals are used as wave-functions of oxygen orbitals, and dissociation energies are derived for various values of the bond angle and the interatomic distance. In the case of H_2O, dissociation energy was 9·39eV, bond angle, 100°, and interatomic distance, 2·0 α_H. In the case of F_2O, these were 5·62eV, 92° and 2·8 α_H. These values are close to the experimental values, as expected. It might be concluded, therefore, that Mulliken's "magic formula" is useful in the calculation of properties of molecules of such type as A–O–A with the help of Pauling's electro-negativity scale. In the Appendix, the numerical values of some overlap integrals between 2*s* 2*p* hybrid atomic orbitals and other atomic orbitals are tabulated. A.

539.132 : 534.222.2

Dissociation of nitrogen in shock waves. *See Abstr.* 7779

539.132

8114. Vibrations and electronic spectra of polyatomic molecules. J. Duchesne. *Mém. Acad. Roy. Belg. Cl. Sci.* (*Coll. in*-8°) **28,** *No.* 8, 74 *pp.* (1955) In French.

A general survey is given of the treatment of such problems. Tetratomic X_2YZ and triatomic molecules of symmetry C_{2v} are discussed and also benzene, symmetry D_{6h}. The potential functions are calculated for the ground states. In the excited states the symmetries are approximately invariant, except for the benzene $\pi \rightarrow \pi^*$ transition. Force and coupling constants are discussed for the various states, and the bonding properties of the electrons are deduced. The degree of delocalization of π-electrons is estimated and this is applied to the cases of $COCl_2$ and $CSCl_2$. A. J. TAYLOR

539.132

8115. Computation and interpretation of the vibration spectrum of iso-butylene. L. M. Sverdlov and O. N. Vinochodova. *Dokl. Akad. Nauk SSSR,* **100,** *No.* 1, 45–8 (1955) In Russian.

The computation is simplified by the use of force coeffs. of ethylene. The method of El'yashevich is used to determine 30 normal vibrations, with bond lengths and angles as vibration co-ordinates. The work of Pitzer and Kilpatrick is considered inaccurate; the present work claiming agreement with experiment to within 10 cm^{-1}. J. JACOBS

539.132

8116. Fundamental vibrations of diatomic molecules. S. S. Mitra. *Z. Phys.,* **140,** *No.* 5, 531–4 (1955) In German.

Two new relations for the calculation of fundamental vibrational frequencies of molecules *XY* in terms of those of *XX* and *YY* are suggested, namely $a^4 = \frac{1}{4}bc(b + c)^4$ and $a^{\frac{1}{2}} = 0{\cdot}48\, b^{\frac{1}{2}} + 0{\cdot}52\, c^{\frac{1}{2}} (c > b)$, where *a*, *b* and *c* are the fundamental frequencies of the molecules *XY*, *XX*, *YY* respectively. These were calculated for a large number of diatomic molecules, good agreement with experimental data being found throughout. A. J. TAYLOR

539.132

8117. Spectroscopic constants of molecules. III. Regularities in vibration frequencies in a molecular group. Y. P. Varshni and K. Majumdar. *Indian J. Phys.,* **29,** *No.* 1, 38–47 (*Jan.,* 1955).

For Pt II, see Abstr. 11271 (1954). Regular variation of vibration frequency ω_e and force constants k_e in a molecular group has been studied. It is shown that, in a molecular group, if the ω_e of the series of molecules of a metallic element are plotted against the ω_e of the corresponding molecules of another metallic element, straight lines are obtained. Unknown ω_e have been predicted. A.

539.132

8118. Theory of the Taylor–Benedict–Strong effect. G. Amat and M. Goldsmith. Letter in *J. chem. Phys.,* **23,** *No.* 6, 1171–2 (*June,* 1955).

Taylor *et al.* have suggested that values for resonance energies to be used in the calculation of vibrational constants should be considered as functions of the vibrational quantum numbers. Here it is shown that when the vibrational Hamiltonian computed to third order is used, these resonance energies do indeed depend on the quantum numbers. A. J. TAYLOR

539.132

8119. The free energy and entropy of dissociation of methylammonium chloride from 276 to 313°K. The barrier hindering internal rotation. J. G. Aston and F. L. Gittler. *J. Amer. Chem. Soc.,* **77,** *No.* 12, 3175–7 (*June* 20, 1955).

The equilibrium pressures of hydrogen chloride and methylamine above solid methylammonium chloride have been determined from 0 to 40° from cell measurements in anhydrous alcohol. The free energies and entropies of dissociation of solid methylammonium chloride and the absolute entropies of methylamine have been determined over the same range. The entropies of methylamine thus determined have been compared with the ones determined from ΔF° and ΔH° and from the spectroscopic data. The barrier hindering internal rotation is 1900 ± 400 cal. $mole^{-1}$ in agreement with the value recently found from the microwave spectrum and not inconsistent with the calorimetric value. The ordered arrangement of methylammonium chloride at 0°K has been confirmed. A.

539.132

8120. Effects of anharmonicity of vibration on the diffraction of electrons by free molecules. L. S. Bartell. *J. chem. Phys.,* **23,** *No.* 7, 1219–22 (*July,* 1955).

The increased experimental precision now attainable in electron diffraction by free molecules has necessitated a re-examination of the methods of interpretation of diffraction data to allow for the effects of non-rigidity of molecules. It is shown that conventional procedures of analysis of data lead to ambiguous results which are likely to differ from the true equilibrium internuclear distances by the order of 0·01 Å. More exact expressions are presented for the intensity of electrons diffracted by vibrating molecules and for the corresponding experimental radial distribution curves in terms of the parameters characterizing the potential fields of the molecules. The case of diatomic molecules is treated in detail, including the effect of temperature, assuming a Morse potential energy function. Some aspects of polyatomic molecules are discussed. A.

539.132

8121. Restricted rotation in amides as evidenced by nuclear magnetic resonance. W. D. PHILLIPS. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1363–4 (*July*, 1955).

Liquid NN dimethyl formamide shows two methyl group proton resonances separated at 30 Mc/s by 6 c/s, which separation is proportional to the field. The two CH_3 groups have therefore different chemical shifts and the rate of rotation about the $HCO–N(CH_3)_2$ bond is less than $38\,sec^{-1}$. Acetamide behaves similarly while in the monomethyl compounds only one of the rotational isomers is present.

D. H. WHIFFEN

539.132

8122. Vibrational transition probabilities of diatomic molecules; collected results. III. N_2, NO, O_2, O_2^+, OH, CO, CO^+. W. R. JARMAIN, P. A. FRASER AND R. W. NICHOLLS. *Astrophys. J.*, **122**, *No.* 1, 55–61 (*July*, 1955).

For Pt II, see Abstr. 1526 (1955). Arrays of approximate vibrational transition probabilities (i.e. overlap integral squares or "Franck–Condon factors") are presented for bands of the following molecular transitions of astrophysical interest: N_2: $a^1\Pi_g \rightarrow X^1\Sigma_g^+$ (Lyman–Birge–Hopfield). NO: $B^2\Pi \rightarrow X^2\Pi$ (β system). O_2: $A^3\Sigma_u^+ \rightarrow X^3\Sigma_g^-$ (Herzberg). $B^3\Sigma_u^- \rightarrow X^3\Sigma_g^-$ (Schumann–Runge). O_2^+: $b^4\Sigma_g^- \rightarrow a^4\Pi_u$ (first negative). OH: $A^2\Sigma^+ \rightarrow X^2\Pi$. CO: $a^3\Pi \rightarrow X^1\Sigma^+$ (Cameron). $a'^3\Sigma^+ \rightarrow a^3\Pi$ (Asundi). CO^+: $A^2\Pi \rightarrow X^2\Sigma^+$ (comet-tail). A.

539.132

8123. Ground state of the helium hydride ion. A. A. EVETT. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1169–70 (*June*, 1955).

James and Coolidge's variation method was applied to the ground state of $(HeH)^+$. Some terms not included in previous work were included and found to influence the binding energy. Values for this energy are tabulated for various internuclear distances, as well as the values of the coefficients. The power limit for the energy is suggested to be between 1·75 and 2·05 eV. A. J. TAYLOR

539.132

8124. Rotational excitation by slow electrons. II. E. GERJUOY AND S. STEIN. *Phys. Rev.*, **98**, *No.* 6, 1848–51 (*June* 15, 1955).

For previous part, see Abstr. 4840 (1955). Theoretical cross-sections for the rotational excitation of homonuclear molecules by slow electrons are applied to calculation of the fractional energy loss per collision (λ) in H_2. The theoretical losses are not more than 2·5 ($2m/M$) and except at the lowest energies studied ($\sim$0·1 eV) are smaller than observed. It would be desirable to have more direct experimental evidence of rotational excitation. For this reason λ has been calculated at 77°K in pure para-hydrogen and in normal hydrogen at that temperature. At electron energies $\sim$0·075 eV, the two λ's should differ by about 50%. Similarly, because of the altered rotational distribution, λ for deuterium differs from λ for H_2. Such differences, if observed, could hardly be accounted for on any other basis than rotational excitation. A.

539.132

8125. Vibrational relaxation times of diatomic molecules and rocket performance. H. C. PENNY AND H. AROESTE. *J. chem. Phys.*, **23**, *No.* 7, 1281–3 (*July*, 1955).

Computations are presented for the variation of vibrational excitation probabilities with temperature for mixtures of O_2 and N_2, and of HF and H_2. The values of six different excitation probabilities in each mixture are reported for temperatures up to 3 000°K For each of the probabilities there is a lower temperature limit given, below which the theory of Schwartz, Slawsky, and Herzfeld, which is used here, is not applicable. Using the results for H_2–HF mixtures, the authors present some considerations which suggest that the expansion through the de Laval nozzle for representative H_2–F_2 rocket motors may be taken as vibrational near-equilibrium flow. A.

539.132

8126. Properties of the hydrogen molecular ion. V. Transitions connecting the lowest even and lowest odd π-states with higher σ-states. J. T. LEWIS, M. R. C. MCDOWELL AND B. L. MOISEIWITSCH. *Proc. Phys. Soc. A*, **68**, *Pt* 7, 565–8 (*July*, 1955).

For Pt IV, see Abstr. 7620 (1954). The transition integrals corresponding to the $2p\pi_u$–$2s\sigma_g$, $2p\pi_u$–$3s\sigma_g$, $2p\pi_u$–$3d\sigma_g$ and $3d\pi_g$–$3p\sigma_u$, $3d\pi_g$–$4p\sigma_u$, $3d\pi_g$–$4f\sigma_u$ perpendicular type transitions of H_2^+ are computed from the exact two-centre wave-functions. A.

539.132 : 535.343

8127. The electronic spectra of aromatic molecules. IV. Excited states of odd alternant hydrocarbon radicals and ions. H. C. LONGUET-HIGGINS AND J. A. POPLE. *Proc. Phys. Soc. A*, **68**, *Pt* 7, 591–600 (*July*, 1955).

For Pt III, see Abstr. 4841 (1955). The lower excited electronic states of some unsaturated hydrocarbon radicals and ions are discussed in terms of molecular orbital theory, taking account of electron interaction. The following results emerge: (i) In the absorption spectrum of an alternant radical there should appear two long wavelength bands. These arise jointly from excitations of electrons into and out of the singly occupied orbital. The lower frequency band should be weak, and the higher frequency band relatively strong. The existence of a low-lying quartet level is also predicted. (ii) The absorption spectra of the corresponding anion and cation should be closely related, the lowest two excited states being for both types of ion a triplet and a singlet. (iii) The singlet–triplet separation in the ions should be roughly equal to the separation of the two low-lying doublets of the radical. These generalizations are supported by the experimental data for certain triaryl-methyl systems. A.

539.132 : 535.343

8128. The electronic spectra of aromatic molecules. V. The interaction of two conjugated systems. H. C. LONGUET-HIGGINS AND J. N. MURRELL. *Proc. Phys. Soc. A*, **68**, *Pt* 7, 601–11 (*July*, 1955).

The electronic spectrum of a composite alternant hydrocarbon R–S is discussed theoretically in relation to the excited electronic states of the separate fragments RH and SH. The lowest excited states of RS are interpreted as arising from two types of excited

configuration. In the first type an electron is raised from an occupied orbital of one fragment to an unoccupied orbital of the same fragment, and in the second, an electron is transferred from one fragment to the other. The self-consistent molecular orbital theory is used to evaluate the interactions between the various configurations, and the molecules butadiene, biphenyl and styrene are examined quantitatively. The following results are worthy of mention: (i) In butadiene the near ultraviolet transition arises primarily from an in-phase combination of local excitations in the two double bonds. (ii) In biphenyl a similar situation arises, there being strong configurational interaction in the perpendicular as well as in the planar conformation. In all three molecules there is quite good agreement between the observed and calculated spectra. A.

539.132

8129. Zeeman splitting of nuclear quadrupole resonance in paradibromobenzene. S. KOJIMA, K. TSUKADA AND Y. HINAGA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 498–502 (*July*, 1955).

Zeeman patterns of the nuclear quadrupole resonance line of Br^{79} were studied with a single crystal of paradibromobenzene. The crystal contains two classes of molecules with equal positive and negative inclinations against the crystallographic *b*-axis. Changing the orientation of magnetic field in the plane perpendicular to the *b*-axis, the Zeeman patterns were measured. The asymmetry parameter of the coupling, η, was determined from the pattern at the magnetic field perpendicular to all carbon–bromine bonds. The result was $\eta = 0{\cdot}12 \pm 0{\cdot}01$. The coupling constant, eQq, was measured as 535·19 Mc/s at 14°c. If the asymmetry parameter is completely due to the resonance of a double bond structure in the carbon–bromine bond, the observed value gives 4·5% double bond character. A.

539.132

8130. Proton magnetic resonance studies of chloroform in solution: evidence for hydrogen bonding. C. M. HUGGINS, G. C. PIMENTEL AND J. N. SHOOLERY. *J. chem. Phys.*, **23**, *No.* 7, 1244–7 (*July*, 1955).

The concentration and temperature dependences of proton magnetic resonance measurements on chloroform in acetone and triethylamine solutions are presented. The behaviour is similar to hydrogen bonding systems and it is concluded that there is a specific interaction involving the chloroform proton and the solvent molecule. In each system the data are consistent with the assumption of a one-to-one complex. Equilibrium constants and heats of formation are calculated. A.

539.132

8131. Origin of the line width of pure quadrupole resonance. Y. KÔI, A. TSUJIMURA AND T. FUKE. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1346 (*July*, 1955).

The quadrupole resonance line shape for $NaBrO_3$ is intermediate between Gaussian and Lorentzian. The width ratio for Br^{79}/Br^{81} is 1·13, which is intermediate between the square of the coupling constants, 1·44, and of the magnetic moment ratio, 0·928. Consequently both quadrupole relaxation and magnetic dipole interactions contribute to the line width. D. H. WHIFFEN

539.132

8132. Multiple resonances in cobalt ferrite. P. E. TANNENWALD. *Phys. Rev.*, **99**, *No.* 2, 463–4 (*July* 15, 1955).

Double microwave resonances have been observed in cobalt ferrite when a magnetic field was applied in crystal directions near the hard axis. One resonance occurs before the magnetization vector is lined up with the external magnetic field and another occurs in the aligned state. The experimental results exhibit characteristic features expected before complete line-up and yield, at 90°c, $K_1/M = 2\,200 \pm 200$ and $g = 2{\cdot}7 \pm 0{\cdot}3$. A.

539.132

8133. Relaxation processes in a system of two spins. I. SOLOMON. *Phys. Rev.*, **99**, *No.* 2, 559–65 (*July* 15, 1955).

Abragam and Pound's method for the calculation of the longitudinal relaxation time T_1 has been extended to the transverse relaxation time T_2. Explicit calculations have been carried out for a pure dipole–dipole interaction, showing that for an interacting pair of like spins, or for nuclei in paramagnetic solution, T_1 is exactly equal to T_2 in the extreme narrow case. For a pair of interacting unlike spins, it is shown that the longitudinal components of the magnetic moments do not have simple exponential decays. This gives rise to a steady and transient Overhauser effect. The transverse components, however, have in all cases, simple exponential decay defined by a single relaxation time T_2. A set of modified Bloch's equations is found, giving the correct equation of motion of the macroscopic magnetic moments of such a system of pairs of unlike spins. The equality of T_1 and T_2 has been verified in paramagnetic solutions, and a nuclear Overhauser effect has been observed in anhydrous hydrofluoric acid. If one assumes that the extreme narrow case corresponds to the actual motion, the experimental results are not consistent with the picture of a pure dipole–dipole interaction between the hydrogen and fluorine nuclei of a molecule without taking into account the effect of the other molecules. A.

539.132

8134. Pure nuclear quadrupole spectra of chlorine and antimony isotopes in solids. T.-C. WANG. *Phys. Rev.*, **99**, *No.* 2, 566–77 (*July* 15, 1955).

Experimental measurements have been made to an accuracy of about 0·001%. The results are compared in detail with theoretical results for (1) nuclear quadrupole interaction, (2) interaction between quadrupole coupling and thermal vibrations, and (3) effects of a nuclear hexadecapole. The ratio $(eQq)_{Cl^{35}}/(eQq)_{Cl^{37}}$ varies between 1·268 736 and 1·268 973 while $(eQq)_{Sb^{123}}/(eQq)_{Sb^{121}}$ varies from 1·274 714 to 1·274 770. These variations may be attributed to zero-point vibrations and to thermal vibrations, so that no clear evidence is found for nuclear polarization by surrounding electric fields. For *p*-dichlorobenzene, the temperature coefficient of the coupling constant of Cl and the variation of isotopic coupling ratio with temperature are shown to be in fair quantitative agreement with the extension of Bayer's theory of vibrational effects. Relaxation times, Zeeman effects, and certain effects due to crystal structure are

examined. Small discrepancies in the measured ratios of frequencies of transitions in Sb^{121} and Sb^{123}, which can be attributed to nuclear hexadecapole interactions are found. These indicate a hexadecapole coupling constant in Sb^{123} of 24 kc/s and a ratio of the Sb^{123} hexadecapole coupling to that of Sb^{121} of $0{\cdot}8 \pm 0{\cdot}3$. A convenient high-sensitivity circuit for observation of nuclear resonances in solids has been developed and is discussed. A.

539.132 : 534.321.9

8135. Saturation of nuclear electric quadrupole energy levels by ultrasonic excitation. W. G. PROCTOR AND W. H. TANTTILA. Letter in *Phys. Rev.*, **98,** *No.* 6, 1854 (*June* 15, 1955).

A 0·3 sec pulse at 5 W of 30·63 Mc/s ultrasonic radiation is found to equalize the $m = \pm 3/2$ and $\pm 1/2$ populations for the Cl^{35} spin states in $NaClO_3$ and so to reduce the quadrupole resonance signal at this frequency to 20% of its natural intensity, 0·03 sec after the end of the pulse. D. H. WHIFFEN

539.132

8136. Investigations on the combined approximation method. H. PREUSS. *Z. Naturforsch.*, **10a,** *No.* 5, 365–73 (1955) In German.

Hellmann first solved the many-electron problem by the combined method, where skeleton electrons are treated statistically, and valence electrons wave-mechanically. The present paper extends the method by using improved variation functions, and more accurate parameters in the additional potential $V(z)$. As a test the energy values of the H atom were determined, with excellent agreement for 1*s*, 2*s*, 2*p* states. J. JACOBS

539.132

8137. Note on hyperconjugation. Y. I'HAYA. Letter in *J. chem. Phys.*, **23,** *No.* 6, 1165 (*June*, 1955).

An attempt is made to develop the MO theory of hyperconjugation by placing the choice of semi-empirical parameters on a more quantitative basis. The value of the parameter δ, the Coulomb integral correction term for quasi-π orbital, is computed to be 0·3. G. I. W. LLEWELYN

539.132

8138. Third-order conjugation energies. Y. I'HAYA. Letter in *J. chem. Phys.*, **23,** *No.* 6, 1171 (*June*, 1955).

The third-order conjugation energies E_3 (CJ) per bond are calculated for various C–C bond lengths by using the theoretically deduced value for δ (see preceding abstract). G. I. W. LLEWELYN

539.132

8139. Absence of hydrogen bonding in an alcohol-fluorohydrocarbon system. R. S. MCDONALD, J. H. GIBBS AND J. R. LADD. Letter in *J. chem. Phys.*, **23,** *No.* 6, 1170 (*June*, 1955).

Measurement of the spectrum of benzyl alcohol in solution in (*a*) benzyl fluoride, (*b*) toluene, and (*c*) anisole indicates that there is little OH–F hydrogen bonding present in (*a*). G. I. W. LLEWELYN

539.132

8140. Simplified SCF calculation for fulvene. H. KON. Letter in *J. chem. Phys.*, **23,** *No.* 6, 1176–7 (*June*, 1955).

The ultraviolet spectrum, dipole moment, and π-electron distribution of fulvene have been calculated. The results are compared with previously-recorded more rigorous calculations. G. I. W. LLEWELYN

539.132

8141. Extension of the calculus of errors to the ensemble of states of a stationary system. A. LAFORGUE. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 22, 2122–4 (*June* 1, 1955) In French.

Previous work [Abstr. 6989 (1953)], concerning only the fundamental state, is now extended to excited states. Limits are found for various errors using waves represented in a functional space. A numerical example is given, relating to a perturbed hydrogen atom. L. S. GODDARD

539.132

8142. Approximate molecular orbitals. III. The $2s\sigma_g$ and $3d\sigma_g$ states of H_2^+. T. R. CARSON AND A. DALGARNO. *Proc. Phys. Soc. A*, **68,** *Pt* 7, 569–76 (*July*, 1955).

For Pt II, see Abstr. 7627 (1954). A modified variational method is used to obtain approximate wave-functions for the $2s\sigma_g$ and $3d\sigma_g$ states of H_2^+. Their accuracy is assessed by comparing various quantities computed using them with the exact values of these quantities. The dependence of the kinetic and potential energies on the nuclear separation is briefly discussed. A.

539.132

8143. Molecular orbitals for the hydrogen molecule ground state. R. F. WALLIS. *J. chem. Phys.*, **23,** *No.* 7, 1256–8 (*July*, 1955).

The ground state energy of the hydrogen molecule has been calculated using a wave-function constructed from LCAO molecular orbitals. The effective nuclear charge in the MO for one electron is taken to be different from that for the MO for the second electron. The best value of the dissociation energy is found to be 3·565 eV for values of the effective nuclear charge equal to 1·5 and 0·9. A physical interpretation of these values of the effective nuclear charge is given. Calculations have also been made using a wave-function having a variable ratio of homopolar terms to ionic terms and having two effective nuclear charges. The best value of the dissociation energy for this case is found to be 4·08 eV. A.

539.133

8144. The effect of solvent in dipole moment measurements. N. PILPEL. *J. Amer. Chem. Soc.*, **77,** *No.* 11, 2949–53 (*June* 5, 1955).

The apparent dipole moments of acetophenone, phenetole, chlorobenzene, nitrobenzene and benzonitrile have been calculated from solution data by the conventional method, and by employment of the solvent effect equations of Sugden, Smith and Goss. The values differ from the true vapour values by amounts which depend on the method of calculation. These differences can be almost completely eliminated by averaging the values obtained by the four different methods. A.

539.133

8145. Molecular structure of diborane tetrachloride, B_2Cl_4. M. ATOJI, W. N. LIPSCOMB AND P. J. WHEATLEY. Letter in *J. chem. Phys.*, **23,** *No.* 6, 1176 (*June*, 1955).

An X-ray diffraction study of a single crystal of

B_2Cl_4 at −165°c indicates that the molecule is planar of D_{2h} symmetry. Interatomic distances and bond angles have been determined. G. I. W. LLEWELYN

539.133

8146. Methyl alcohol. II. Molecular structure. P. VENKATESWARLU AND W. GORDY. *J. chem. Phys.*, **23**, *No.* 7, 1200–2 (*July*, 1955).

For Pt I, see Abstr. 7855. From the moments of inertia of six different isotopic species of methyl alcohol as obtained from the $J = 0 \rightarrow 1$ rotational lines a complete structural determination of methyl alcohol has been made. The structural parameters so obtained are the following: $d_{OH} = 0{\cdot}956 \pm 0{\cdot}015$ Å, $d_{CO} = 1{\cdot}427 \pm 0{\cdot}007$ Å, $d_{CH} = 1{\cdot}096 \pm 0{\cdot}010$ Å, $\angle HCH = 109°2' \pm 45'$, $\angle COH = 108°52' \pm 2°$, and the distance of the oxygen atom from the symmetry axis of the CH_3 group $= 0{\cdot}083 \pm 0{\cdot}005$ Å. A.

539.133

8147. Temperature dependency of the statistical segment size of polyethylene. R. J. VOLUNGIS AND R. S. STEIN. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1179 (*June*, 1955).

The difference of the principal polarizabilities of stretched crosslinked polyethylene decreases with increasing temperature in the region 120–170°c. If this difference is proportional to the length of the statistical segment this implies a transition from the low temperature planar transconfiguration to a high temperature twisted one, caused by rotation about C–C bonds. P. CUCKA

ATOMS . NUCLEUS . ISOTOPES 539.15

539.152.1

8148. The statistical theory of the nucleus. III. P. GOMBÁS, E. MÁGORI, B. MOLNÁR AND É. SZABÓ. *Acta phys. Hungar.*, **4**, *No.* 3, 267–72 (1955) In German.

The density distributions and energies for $A =$ 16, 80, 200 were calculated using the same variational method as in Abstr. 6690, 8991 (1952), but for a 2-body interaction of exponential or Gaussian type. The former gives the best fit with empirical mass defects. The corresponding density is roughly Gaussian at $A = 16$, but at $A = 80$ and $A = 200$ a central depression has developed. W. J. SWIATECKI

539.152.1

8149. Contribution to the statistical theory of the nucleus. W. INTHOFF. *Ann. Phys.* [*Leipzig*] **15**, *No.* 7–8, 376–93 (1955) In German.

By requiring $\delta E/\delta\rho$ to be zero, an equation for ρ is obtained, since the potential and kinetic energies are first expressed in terms of ρ (and an approximate form for the mixed density is chosen). The resulting integral equation is solved approximately by "Koliokationsmethode," i.e., by choosing an approximate solution with variable parameters and requiring that the equation is satisfied at certain points. Formulation of more general equations in which the energy is made an extremum for variations of densities of protons and neutrons with either spin up or down, is described. G. E. BROWN

539.152.1

8150. On the distribution of protons in heavy nuclei. P. MITTELSTAEDT. *Z. Naturforsch.*, **10a**, *No.* 5, 379–83 (1955) In German.

The correct numbers of protons and neutrons can only be obtained by choosing different nuclear-force potentials for each type of particle. The Coulomb potential is calculated for protons and in accordance with the qualitative idea of Johnson and Teller [Abstr. 4829 (1954)]. This leads to a shorter range of protons than of neutrons. Numerical calculations are carried out using the statistical model of the nucleus for Pb_{82}^{207}. G. E. BROWN

539.152.1

8151. Nuclear binding energies. J. MATTAUCH. *Science*, **121**, 745–50 (*May* 27, 1955).

For abstract, see Abstr. 2987 (1955).

539.152.1

8152. Excited states of Ce^{140}. H. H. BOLOTIN, C. H. PRUETT, P. L. ROGGENKAMP, AND R. G. WILKINSON. *Phys. Rev.*, **99**, *No.* 1, 62–7 (*July* 1, 1955).

Scintillation and magnetic β-ray spectrometry have been applied to the study of the more important levels of Ce^{140}. Coincidence experiments verify that successive levels are at 1·60, 2·09, 2·42 and 2·53 MeV above the ground state and correspond to γ-rays of energies 1·60, 0·815, 0·490, 0·438 and 0·328 MeV. The relative intensities of the γ-rays are found to be 2·50, 1·15, 1·25, 0·15 and 1·00, respectively. The energies and relative intensities of two weak high-energy transitions have been determined by means of a scintillation pair spectrometer. Values of $2{\cdot}50 \pm 0{\cdot}05$ and $3{\cdot}00 \pm 0{\cdot}20$ MeV are obtained with corresponding intensities of 1% and 0·04% of the 1·60 MeV γ-ray. The β-ray measurements substantiate the relative intensities and end-point energies of the β-ray groups which have been reported by others. In addition, it has been possible to estimate the internal conversion coefficients and K/L ratios. The angular correlation of four cascade pairs of the above γ-rays has been studied. The results obtained, together with the β-ray and internal conversion data, are most consistent with the assignment 0, 2+, 4+, 3+ for the ground state and first three excited states. The assignment 0, 2+, 4+, 4+ cannot be definitely excluded. A.

539.152.1

8153. On the imaginary part of the nucleon–nucleus potential. E. CLEMENTEL AND C. VILLI. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 176–9 (*July*, 1955).

The complex part of the potential, V_1, is estimated by averaging the nucleon–nucleon cross-sections over a Fermi gas distribution for particles in a well. The energy dependence of V_1 is thus found in terms of the real part of the potential. Results are in satisfactory agreement with direct empirical evaluation of V_1.

P. T. MATTHEWS

539.152.1

8154. A note on nuclear temperatures at low excitation energies. D. L. LIVESEY. Note in *Canad. J. Phys.*, **33**, *No.* 7, 391–3 (*July*, 1955).

It is suggested that the nuclear temperature may be constant for excitation energies up to 10 MeV; the nuclear level density should then increase with

energy according to a simple exponential law. The energy distribution of neutrons evaporated from copper irradiated by 70 MeV bremsstrahlung is shown to be consistent with this law. Examples from the literature are also cited, and a possible reason for the constant temperature is suggested. J. M. CASSELS

539.152.1

8155. Spacings and neutron widths of nuclear energy levels. J. A. HARVEY, D. J. HUGHES, R. S. CARTER AND V. E. PILCHER. *Phys. Rev.*, **99**, *No.* 1, 10–33 (*July* 1, 1955).

The parameters of nuclear energy levels at excitation energy just above neutron binding have been studied for about 20 heavy nuclides. Total cross-sections for neutrons of energy 0 to 700 eV were made utilizing the Brookhaven fast chopper and the transmissions were analysed to obtain the resonance parameters. The reduced neutron widths, Γ_n^0, show a wide variation among the resonances in single nuclides relative to radiation widths, Γ_γ. Within experimental error, the size distribution of the reduced neutron widths is exponential, the most probable width being zero. The experimental level spacings, D, exhibit discontinuities at closed shells, an effect that remains after correction of the spacings for differences in excitation energy. The ratio Γ_n^0/D, of particular significance to the "cloudy crystal ball" nuclear model, has a maximum about $A = 160$, as expected from theory, but of a much smaller magnitude than the computed peak. A.

539.152.1

8156. Nuclear energy level fine structure and configuration mixing. K. A. BRUECKNER, R. J. EDEN AND N. C. FRANCIS. *Phys. Rev.*, **99**, *No.* 1, 76–87 (*July* 1, 1955).

The departure of shell-model states from independent-particle states is investigated by means of transformation methods developed in previous papers. The starting point in this paper is the many-body Schrödinger equation for the nucleus in which the potential energy is assumed to arise from strong short-range two-body interactions. As a consequence the shell-model wave-function cannot be a solution of this equation, however it can be related to the actual nuclear wave-function by a suitably chosen transformation operator. This operator preserves the energy and angular momentum of low-lying nuclear states; hence it is possible to examine the splitting of energy levels in the shell model space. For a closed shell plus two or three particles this is shown to originate primarily from perturbations due to two-body interactions between the particles outside the shell. The methods used also give information about the nuclear wave-function and provide some justification for the use of configuration mixing in determining nuclear magnetic moments. It is noted that the successes of configuration mixing based on two-body forces provide evidence that two-body correlations dominate over many-body correlations for many properties of the nucleus. A.

539.152.1

8157. Effect of spin-orbit interaction on photonuclear electric dipole absorption. S. FRANKEL. *Phys. Rev.*, **99**, *No.* 1, 169 (*July* 1, 1955).

The effect of a nuclear spin-orbit interaction of the form $H_1 = \phi(r)\mathbf{1}\cdot\boldsymbol{\sigma}$ on photonuclear electric dipole absorption is examined. It is found that the total cross-section is unaffected and expressions are given for the (small) effect on the average energy of absorption. A.

539.152.1

8158. Collective modes in nuclei. F. COESTER. *Phys. Rev.*, **99**, *No.* 1, 170–4 (*July* 1, 1955).

The Hamiltonian of the "unified model" of Bohr and Mottelson has been derived from many-particle quantum mechanics. A point transformation in the configuration space of the N nucleons of the core introduces 6 collective co-ordinates describing the size and shape of the nucleus and $3N$-6 internal co-ordinates. The collective co-ordinates are essentially the components of the quadrupole moment tensor of the nucleon distribution. It is assumed that the wave-function Ψ of the nucleus for the ground state and the low lying excited states can be approximated by the product $\Psi_0\Phi$ where Ψ_0 depends only on the internal co-ordinates of the core and Φ depends on the collective co-ordinates of the core and the co-ordinates of the external nucleons. $\Psi_0\Phi$ is treated as a trial function in the Schrödinger variational principle. For fixed Ψ_0 this yields a Schrödinger equation for Φ. The Hamiltonian in this equation is the Hamiltonian of Bohr and Mottelson plus certain correction terms. Ψ_0 influences the values of the constant parameters occurring in this Hamiltonian but not its structure. In the strong-coupling approximation the relationship between the moments of inertia of the core and the nuclear quadrupole moment is essentially the same as in the liquid drop model. This result is also independent of detailed assumptions about Ψ_0. A.

539.152.1

8159. Energy levels of Pb^{208}. G. E. TAUBER. *Phys. Rev.*, **99**, *No.* 1, 176–9 (*July* 1, 1955).

The various hole-particle configurations in the neighbourhood of the doubly magic nucleus $Z = 82$, $N = 126$ have been investigated and applied to the excited states of Pb^{208}. For a particle-particle interaction of the form $V = (mP + nQ)V(|\mathbf{r}_1 - \mathbf{r}_2|)$, where P denotes Majorana and Q Bartlett forces, the energy levels have been calculated in the L-S and j-j limit both for a delta-type and Gaussian potential with various ranges and compared with the experimental results. A.

539.152.1

8160. Intermediate coupling in odd-odd nuclei. R. ADKINS AND J. G. BRENNAN. *Phys. Rev.*, **99**, *No.* 3, 706–8 (*Aug.* 1, 1955).

An intermediate-coupling model is applied to the structure of lithium-6 and nitrogen-14. A ground-state wave-function is selected which reproduces the observed ground-state moment data. A two-body potential, with spin-orbit and tensor forces included, is sought which will have the proper wave-function as its lowest state and which will reproduce the observed level splitting of the lower excited states of the nucleus. The usual variational method is used, the potential is assumed to have a Yukawa radial dependence, and the wave-functions are assumed to have an harmonic oscillator radial dependence. Only the p-shell nucleons are included. This procedure leads to a

consistent, but not unique, result for lithium requiring a strong tensor force for satisfactory solutions. When the additional requirement of the near vanishing of the carbon-14–nitrogen-14 β-decay element is imposed, and the procedure repeated for the nitrogen nucleus, the results are much less satisfactory. Very large and physically unmeaningful values of the potential parameters appear to be needed to obtain agreement with experimental data. A.

539.152.2

8161. The action of a rotating magnetic field on the resonance of a system of spins. J. SEIDEN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 23, 2228–30 (*June* 6, 1955) In French.

Calculation of the shift of resonance frequency of a spin system in a magnetic field when a perpendicular rotating magnetic field is applied. D. H. WHIFFEN

539.152.2

8162. The time T_2 in nuclear magnetic resonance in liquids. Y. AYANT. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 23, 2230–2 (*June* 6, 1955) In French.

The exact magnetic dipole coupling expression is used to evaluate spin-spin relaxation times in nuclear magnetic resonance and the line shape shown to be Lorentzian. The relationship of line width to T_1 and T_2 varies with their relative magnitudes.

D. H. WHIFFEN

539.152.2

8163. Overhauser nuclear polarization effect. W. A. BARKER AND A. MENCHER. Letter in *Phys. Rev.*, **98**, *No.* 6, 1868–9 (*June* 15, 1955).

Overhauser considered a system of nuclei and electrons in which nuclear spin flip occurred accompanied by electron spin flip in the opposite direction. The following two independent processes are treated here by the perturbation method of Overhauser: (1) nuclear spin flip and electron spin flip in the same sense; and (2) nuclear spin flip without an accompanying electron spin flip. For the case of Li, the fraction of nuclei relaxing by the first of these processes is found to be less than 1% of the fraction relaxing by the Overhauser process. L. PINCHERLE

539.152.2

8164. Nuclear spin and magnetic moment of 3·1-hr Cs^{134m}. L. S. GOODMAN AND S. WEXLER. *Phys. Rev.*, **99**, *No.* 1, 192–8 (*July* 1, 1955).

The nuclear spin, hyperfine structure constant and magnetic moment of the excited isomer 3·1-hr Cs^{134m} were determined by means of the atomic beam magnetic resonance method. The intensity of the active species was measured by deposition of the beam on a cold surface and subsequent counting. A spin of $8(\hbar)$, a h.f.s. $\Delta\nu = 3\,684{\cdot}3 \pm 0{\cdot}5$ Mc/s, and a nuclear moment of $1{\cdot}10 \pm 0{\cdot}01$ nm were found. The nuclear magnetic moment proved to be positive in sign. A.

539.153

8165. Further calculations on electron excitation of forbidden lines: transitions with electric quadrupole moments. M. J. SEATON. *Proc. Roy. Soc. A*, **231**, 37–52 (*July* 19, 1955).

Collisional excitation of the ground configuration terms of various ions such as O I, O II, O III, N I, N II and S II is of importance in various cosmic sources. The collision strengths defined as $\Omega(n', n) = k_n^2 \omega_n Q(n \to n')/\pi$, have been calculated previously for a number of transitions dependent on pure exchange coupling. The present paper is concerned with the potential coupling terms for those transitions having electric quadrupole moments. For partial waves other than the p-wave the coupling strength is sufficiently weak for the distorted wave (D.W.) approximation to be used. The general theory of the D.W. approximation is discussed for complex atoms. It is shown that the angular and spin integrations occurring in the expressions for the collision strengths may be expressed in terms of the angular and spin integrations occurring in the calculation of electric multipole moments. Results of detailed numerical calculations are considered to be correct to within 30 to 40%. A.

539.153 : 537.567

8166. Electron affinity of atomic oxygen. L. M. BRANSCOMB AND S. J. SMITH. Letter in *Phys. Rev.*, **98**, *No.* 4, 1127–8 (*May* 15, 1955).

Reports determination of this quantity by measurement of the cross-section and threshold frequency for photodetachment of electrons from a beam of O^- ions by radiation of measured intensity and spectral distribution [see Abstr. 6254 (1955)]. The result for the electron affinity of O^- is $1{\cdot}45 \pm 0{\cdot}15$ eV, conflicting with previous values. J. HAWGOOD

539.153.4

8167. Application to perturbation theory to the helium atom. J. M. GERHAUSER AND F. A. MATSEN. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1359 (*July*, 1955).

Fourth-order perturbation theory beginning from hydrogen-like functions gives a result for the energy better than the Hartree calculation. G. E. BROWN

539.153.4

8168. Wave functions, spin-orbit, and spin-spin parameters for the $1s^2 2s^2 2p^4$ isoelectronic sequence. H. ZIRIN. *Astrophys. J.*, **122**, *No.* 1, 52–4 (*July*, 1955).

Variational wave-functions are presented for the $1s^2 2s^2 2p^4$ isoelectronic sequence, for the ions O I through Ca XIII. These wave-functions make possible the computation of the spin-orbit and spin-spin parameters for the ions noted. The results agree well with empirical values. A.

539.153.4

8169. Atomic energy levels for the Thomas–Fermi and Thomas–Fermi–Dirac potential. R. LATTER. *Phys. Rev.*, **99**, *No.* 2, 510–19 (*July* 15, 1955).

The eigenvalues of the Schrödinger equation have been obtained for the Thomas–Fermi and Thomas–Fermi–Dirac atomic potentials. Electron self-interactions were taken into account by modifying the potentials to give asymptotically the field of a unit charge. All levels were treated from $1s$ to $7d$ for a range of Z-values sufficient to permit easy interpolation. It was found that the energies, for either the Thomas–Fermi or Thomas–Fermi–Dirac potentials, agree in general as well with experimental ionization energies as the Hartree or Hartree–Fock approximations. Applications of the statistical potential to other atomic problems are indicated. A.

539.154.2

8170. Fundamental considerations in the periodic system of elements. S. K. ASUNMAA AND R. LEPSIUS. Note in *Naturwissenschaften*, **42**, *No.* 8, 208 (1955) In German.

For previous part, see Abstr. 4881 (1955). Derives a new characteristic boundary line (β-line) in the $P/(N-P)$ diagram, where P is the number of protons and N that of neutrons in the nuclei. The new line applies to the unstable isotopes, often coinciding with the previously introduced Z-line for the stable isotopes. It is found that, except for 7 isotopes (of some uneven elements), all other β-active isotopes examined (419 in all) are divided by the new line into the β^-- and β^+-active isotopes. F. LACHMAN

539.154.2

8171. Calculation of the atomic mass and the mean atomic number of mixtures and compounds. H. TELLEZ-PLASENCIA. *Ann. Phys.* [*Paris*] **10**, 479–80 (*May–June*, 1955) In French.

539.155.2/.4

8172. Determination of isotopic masses and abundances by mass spectrometry. A. O. NIER. *Science*, **121**, 737–44 (*May* 27, 1955).

For abstract, see Abstr. 2091 (1955).

539.155.2

8173. Thermal diffusion column for concentrating tritium in tritium-hydrogen mixtures. E. ALMQVIST, K. W. ALLEN AND J. H. SANDERS. *Rev. sci. Instrum.*, **26**, *No.* 7, 649–51 (*July* 1955).

A hot wire thermal diffusion column of the type described by Clusius and Dickel has been constructed to increase the concentration of tritium in tritium–hydrogen mixtures. The column, 350 cm long and 2·86 cm dia., produced an equilibrium separation factor of 680 when filled to a pressure of 64 cm of mercury with hydrogen containing 3·5% tritium. A.

539.155.2 : 537.534.3

8174. Determination of the relative abundance of Li^7/Li^6 with a 15° magnetic sector field mass spectrometer developed from a new aspect. M. J. HIGATSBERGER. *Acta phys. Austriaca*, **9**, *No.* 2, 179–86 (1955) In German.

A detailed description of the instrument is given. The ratio Li^7/Li^6 was found to be $12{\cdot}48 \pm 0{\cdot}04$, after correcting for the different vapour pressures of the two isotopes. J. HUGHES

539.155.2 : 545.823

8175. The determination of isotope ratios by infrared gas analysis. J. C. KLUYVER. *Recueil Trav. chim. Pays-Bas*, **74**, *No.* 5, 322–5 (*May*, 1955).

A new method is described for the determination of the abundance ratios of stable isotopes. The method is based on the difference in the infrared absorption spectra of isotopic molecules. The infrared isotope analyser developed is a relatively simple instrument and succeeds in the measurement of C^{13} abundance in 20 mg of CO_2, with an error of 0·005 at. % C^{13}, and N^{15} abundance in 8 mg of NNO with an error of 0·015 at. % N^{15}, in the neighbourhood of the natural abundances of C^{13} and N^{15} respectively. A.

539.155.4

8176. Masses of light nuclei. A method for correcting a table of masses for new data. J. E. DRUMMOND. *Phys. Rev.*, **99**, *No.* 3, 709–10 (*Aug.* 1, 1955).

A formula is derived for correcting a set of least squares solutions for new data. Two examples are given to show how this method can be easily applied to correct the author's own table of masses. A.

539.155.4 : 537.534.3

8177. Precise measurement of radioactive isotope masses by mass spectrography. J. M. DELFOSSE. *Ann. Soc. Sci. Bruxelles I*, **69**, *No.* 1, 27–8 (1955) In French.

Using sensitive nuclear plates, positions of active isotope lines are marked by (broad) tracks of emitted radiation; comparison lines from stable isotopes are used in the discharge. The method has been used for Rn with Kr as comparison. N. M. KING

RADIOACTIVITY . α-, β- AND γ-RAYS 539.16

539.16.08

8178. Analyzing for low energy gamma emitters in a radio nuclide mixture. U. L. UPSON, R. E. CONNALLY AND M. B. LEBOEUF. *Nucleonics*, **13**, *No.* 4, 38–42 (*April*, 1955).

A scintillation detector is employed with a 2 mm thick NaI crystal and a single-channel pulse analyser. The method is particularly useful for detecting Pu by means of its 100 keV γ-radiation in the presence of a very large fission product background. In this application the single counting channel selects radiation between 90–114 keV and the fission product background in this channel is subtracted electrically as a previously determined ratio of the counts above 114 keV. L. R. SHEPHERD

539.16.08

8179. Using bremsstrahlung detection by a scintillator for simplified beta counting. R. LOEVINGER AND S. FEITELBERG. *Nucleonics*, **13**, *No.* 4, 43–5 (*April*, 1955).

A well-type NaI crystal is used to detect the bremsstrahlung from a liquid sample in a Pyrex tube. The external and internal bremsstrahlung yields from P^{32} are discussed. An efficiency of 0·8 counts per 100 disintegrations was obtained with P^{32}. L. R. SHEPHERD

539.16.08

8180. Identification of charged particles with a crystal telescope. B. WOLFE, A. SILVERMAN AND J. W. DEWIRE. *Rev. sci. Instrum.*, **26**, *No.* 5, 504–10 (*May*, 1955).

An electronic technique is described for identifying non-relativistic charged particles. The ionization and energy of the particle are measured in a two-crystal telescope, and the product $E(dE/dx)$ is obtained electronically. Since $E(dE/dx) \sim M^{0\cdot8}Z^2$ particles of different mass and/or charge can be separated. A.

539.16.08

8181. Ionizing particles from an active deposit of actinium detected by photographic emulsion. M. ADER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 22, 2138–40 (*June* 1, 1955) In French.

By placing photographic plates at varying distances

from an active deposit of actinium the ranges in air of the α-particles emitted have been determined. Two well-known groups at 4·5 and 6·0 cm were found in addition to a lesser known group at 9–10 cm and a group of still longer range; they occurred in the ratio 100 : 15 for 3×10^8 α-particles from the decay of actinium-C (the 4·5 cm group). D. J. PROWSE

539.163

8182. Theoretical analysis of the charge distribution on the recoil Cl ions from *K* capture in A^{37}. R. A. RUBENSTEIN AND J. N. SNYDER. *Phys. Rev.*, **99**, *No.* 1, 189–90 (*July* 1, 1955).

An analysis of the charge spectrum of the recoil Cl ions which result from *K* capture in A^{37}, recently measured by Kofoed–Hansen, is made using recently computed Auger transition rates. It is shown that this charge spectrum, a previously measured fluorescence yield of 0·1 in Cl, and a previously measured *K*/*L* capture ratio of 0·92/0·08 in A^{37} are not consistent. A.

539.163

8183. Energies of the radiations from Co^{57} and Co^{58}. J. M. CORK, M. K. BRICE AND L. C. SCHMID. *Phys. Rev.*, **99**, *No.* 3, 703–5 (*Aug.* 1, 1955).

Using magnetic and scintillation spectrometers the energies of the radiations from Co^{57} and Co^{58} have been evaluated. Several γ-rays not previously reported have been observed. Co^{57} decays mainly by *K* capture but also to a slight extent by positron emission with an upper energy limit of about 300 keV, followed by γ-rays with energies 14·6, 29, 99·8, 122·8, 137·4 and 700 keV. Co^{58} decays by *K* capture and with positron emission of upper energy 485 $\pm$ 10 keV. Gamma-rays with energies of 814 and 500 and possibly 1 300 keV accompany the decay. A.

539.163

8184. K^{40} branching ratio. A. MCNAIR, R. N. GLOVER AND H. W. WILSON. *Phys. Rev.*, **99**, *No.* 3, 771 (*Aug.* 1, 1955).

The ratio of γ- to β-transitions occurring in the decay of K^{40} has been accurately determined by two different counting methods, yielding the ratios 0·124 $\pm$ 0·002 and 0·121 $\pm$ 0·004, respectively. A.

539.163.1

8185. Half-life of Cs^{137}. D. M. WILES AND R. H. TOMLINSON. *Phys. Rev.*, **99**, *No.* 1, 188 (*July* 1, 1955).

The half-life of Cs^{137} was found to be 26·6 $\pm$ 0·4 years by observing the disintegration rate of a known number of atoms. The disintegration rate was measured with a 4π-proportional counter and the number of atoms was determined from isotope dilution data obtained with a mass spectrometer. A.

539.163.1 : 778.34

8186. On a new method for study of radioactive phenomena: cinenucleography. Application to measurement of the period of radium C′. M. LAPORTE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2069–71 (*May* 23, 1955) In French.

A source of pure RaC′, vaporized on to the edge of a rotating disk is moved past a nuclear photographic emulsion. Its rate of decay is shown by the diminishing density of tracks in the emulsion, and counting them gives a direct determination of the period $Y = 1\cdot5\times10^{-4}$ sec. P. ROTHWELL

539.163.2

8187. Study of the disintegration of Pd^{103}. P. AVIGNON, A. MICHALOWICZ AND R. BOUCHEZ. *J. Phys. Radium*, **16**, *No.* 5, 404–10 (*May*, 1955) In French.

Beta-spectrometer and scintillation-counter studies of the γ-radiation following the decay of Pd^{103} show that 90% of the transitions lead to the 40 keV level and 10% to that at 53 keV in Rh^{103}. Weakly excited levels at 300 keV (2×10^{-4}), 365 keV (3×10^{-3}) and 538 keV (4×10^{-4}) were also found. Spin assignments are discussed. M. A. GRACE

539.163.2

8188. Isobaric triplet Cr^{48}–V^{48}–Ti^{48}. R. K. SHELINE AND J. R. WILKINSON. *Phys. Rev.*, **99**, *No.* 1, 165–8 (*July* 1, 1955).

Cr^{48} has been produced by the nuclear reaction $Ti^{46}(\alpha, 2n)Cr^{48}$. The γ-spectra of this nuclide have been investigated and peaks found at 118 keV and 307 keV. The two γ-rays are in coincidence and have the same intensity. The γ-rays of the daughter nuclide V^{48} have been shown to appear in the γ-spectra as Cr^{48} decays. The half-life of Cr^{48} has been determined at 24 $\pm$ 1 hours. The energy of the Cr^{48} orbital electron capture has been shown to be approximately 1·30 MeV with a very low log *ft* value. A decay scheme for the isobaric triplet Cr^{48}–V^{48}–Ti^{48} is proposed. Using the proposed decay schemes as a basis, the masses of Cr^{48} and V^{48} have been calculated to be 47·96934 $\pm$ 22 and 47·96749 $\pm$ 7, respectively. A.

539.163.2

8189. Decay properties of U^{232}. F. ASARO AND I. PERLMAN. *Phys. Rev.*, **99**, *No.* 1, 37–41 (*July* 1, 1955).

The α- and γ-spectra of U^{232} have been studied with an α-particle spectrograph and γ-ray scintillation, proportional, and coincidence counters. Alpha-groups of 5·318 MeV (68%), 5·261 MeV (32%) and 5·134 MeV (0·32%) and γ-rays of 57·9 keV (0·21%), 131 keV (0·075%), 268 keV (0·004%) and 326 keV (0·004%) were observed. The half-life of the 58-keV first excited state of Th^{228} was found to be less than 10 μsec. Spins and parities are assigned to the energy levels, and the results are evaluated with respect to the developing theory and systematics of complex α-spectra and excited states of even-even nuclei. A.

539.163.2

8190. Decay of U^{232} (74 yr). G. SCHARFF-GOLDHABER, E. DER MATEOSIAN, G. HARBOTTLE AND M. MCKEOWN. *Phys. Rev.*, **99**, *No.* 1, 180–3 (*July* 1, 1955).

The decay of the α-emitter U^{232} (74 yr) was studied by means of γ-ray scintillation counters and by a technique involving the impregnation of a scintillating crystal with this source. Excited states were found at 60 keV, 190 keV and 330 keV. The first two are interpreted as rotational states of character 2+ and 4+ and the third as probably a 1— state. The

branching ratios for transitions from the 330-keV state to the 2+ state and ground state are 57% and 43% respectively. The half-life of the 60-keV state was found to be shorter than 2×10^{-8} sec, in contrast to earlier reports based on a study of the β^--decay of Ac^{228}. A.

539.163.2

8191. Average number of neutrons per spontaneous fission of Cm^{244}. G. H. Higgins, W. W. T. Crane and S. R. Gunn. *Phys. Rev.*, **99**, *No.* 1, 183 (*July* 1, 1955).

The average number of neutrons per fission, ν, for Cm^{244} has been measured by the manganous sulphate moderator-absorber system. The value $2\cdot60 \pm 0\cdot11$ has been determined. A.

539.163.2

8192. Decay of Bi^{207}. D. E. Alburger and A. W. Sunyar. *Phys. Rev.*, **99**, *No.* 3, 695–702 (*Aug.* 1, 1955).

Bi^{207} has been found to decay by electron capture accompanied by γ-rays of energies $0\cdot569 \pm 0\cdot0015$, $0\cdot894 \pm 0\cdot007$, $1\cdot0639$, $1\cdot43 \pm 0\cdot01$ and $1\cdot771 \pm 0\cdot005$ MeV having transition intensities of 100 : 0·16 : 87 : 0·16 : 8% per disintegration, respectively. *K*-conversion electron intensities are 1·7, 0·0039, 8·2, 0·0009 and 0·022 electrons per 100 disintegrations, respectively. The 0·894, 1·43 and 1·771 MeV transitions have *K*-conversion coefficients of $(2\cdot4 \pm 1)\times10^{-2}$, $(5 \pm 2)\times10^{-3}$ and $(2\cdot5 \pm 0\cdot5)\times10^{-3}$. The first of these is in agreement with *M*1 radiation and the latter two with *E*2 or *E*2 + *M*1 radiations. Electron capture branches are 87% to the $i_{13/2}$ state at 1·633 MeV, 5 ± 2% to the 0·57 MeV first excited state and 8 ± 2% to a level at 2·35 MeV. Branching to the 2·35 MeV level proceeds only by *L*-capture as shown from the X-ray spectrum in coincidence with $1\cdot78 + 0\cdot57$ MeV photopeak sum pulses. The decay energy to the 2·35 MeV level thus lies between 15 and 90 keV and the total Bi^{207} decay energy is $2\cdot40 \pm 0\cdot04$ MeV. Gamma-γ and electron-γ correlation experiments confirm the 1·06–0·57 MeV cascade as 13/2→5/2→1/2 while the 1·78–0·57 MeV γ-γ correlation is isotropic to within 5%. A spin $\geqslant 7/2$ for the 2·35 MeV state is supported by a cross-over intensity of $< 6\times10^{-5}$ per disintegration as determined with a photoneutron detector. An assignment of $f_{7/2}$ to the 2·35 MeV level is compatible with all of the data including the 1·78–0·57 MeV angular correlation, if the 1·78-MeV transition is assumed to consist of a mixture of ~94% *E*2 and ~6% *M*1. Fast-coincidence techniques have been used to show that the 0·57 MeV level has a lifetime of $< 4\times10^{-10}$ sec. A.

539.163.2

8193. Decay of Sc^{47}. W. S. Lyon and B. Kahn. *Phys. Rev.*, **99**, *No.* 3, 728–30 (*Aug.* 1, 1955).

Sc^{47} was milked from Ca^{47}, prepared by proton irradiation of CaO, and its radiations were studied by coincidence and γ-ray spectrometry. Sc^{47} was found to decay with the emission of β-rays of $0\cdot46 \pm 0\cdot02$ and $0\cdot62 \pm 0\cdot03$ MeV maximum energy. 66 ± 3% of the decay is accompanied by a $0\cdot157 \pm 0\cdot007$ MeV γ-ray in coincidence with the 0·46-MeV β-rays. A.

539.163.2

8194. Decay scheme of Y^{92}. W. A. Cassatt, Jr and W. W. Meinke. *Phys. Rev.*, **99**, *No.* 3, 760–4 (*Aug.* 1, 1955).

The γ-radiations of Y^{92} have been investigated with a scintillation spectrometer. The Y^{92} was produced in a cyclotron by a (d, α) reaction on zirconium and was not contaminated with Y^{91} or Y^{93} isotopes present in fission product solutions. Gamma-rays of $0\cdot21 \pm 0\cdot01$, $0\cdot475 \pm 0\cdot02$, $0\cdot94 \pm 0\cdot03$, $1\cdot45 \pm 0\cdot10$, $1\cdot9 \pm 0\cdot10$ and $2\cdot4 \pm 0\cdot10$ MeV have been observed and both β-γ and γ-γ coincidences of the lower-energy lines tabulated. A decay scheme is proposed which is consistent with the experimental data and with recent data on Nb^{92} and Nb^{92m} reported in the literature. A.

539.164

8195. Absolute alpha counting. M. L. Curtis, J. W. Heyd, R. G. Olt and J. F. Eichelberger. *Nucleonics*, **13**, *No.* 5, 38–41 (*May*, 1955).

A low-geometry α-counter suitable for high-activity samples is described. This counter is so designed that geometric calibration is easily carried out. Use of Al absorption measurements to determine α-particle range and backscattering and self-absorption corrections is outlined. L. R. Shepherd

539.164

8196. Alpha spectrum in the decay of Li^8. R. T. Frost and S. S. Hanna. *Phys. Rev.*, **99**, *No.* 1, 8–9 (*July* 1, 1955).

The α-particle spectrum in the successive β-α decay of Li^8 was observed with magnetic analysis from 1 to 6·5 MeV, corresponding to excitation energies in Be^8 from 2 to 13 MeV. The only definite structure in the spectrum corresponds to the well-known broad state at 2·9 MeV. A.

539.164.2 : 539.152.1

8197. On the theory of alpha disintegration and the determination of nuclear radii. H. A. Tolhoek and P. J. Brussaard. *Physica*, **21**, *No.* 6, 449–70 (*June*, 1955).

Several changes are proposed in the theory of α-disintegration, namely: (*a*) A density distribution, characterized by two parameters, the nuclear radius, *R*, and the surface thickness, *s*, is assumed for the nucleons of the nucleus. (*b*) The potential for the α-particles is composed of the Coulomb potential and a nuclear potential well falling off gradually near the nuclear surface. A relation between the nuclear potential well and the nuclear density distribution is assumed, which contains the range of nuclear forces β and the radius of the α-particle, β_α. (*c*) The depth V_0 is assumed to be much larger than before (about 167 MeV instead of 30 MeV). (*d*) The frequency ν_α with which the α-particle hits the potential barrier is assumed to be much smaller than before (smaller by a factor of about 10^3). The estimates of V_0 and ν_α are based on the independent particle model of the nucleus, with a common potential well for the nucleons. Numerical calculation of the nuclear radius *R* for the case of Po^{214} gave a value of $r_0 \simeq 1\cdot13\times10^{-13}$ cm (where $R = r_0A^{\frac{1}{3}}$) with the improved theory. Although the accuracy of this determination should not be overestimated, it may at least be concluded that no contradiction is apparent

between the determination of nuclear radii from α-decay and the newer methods using X-rays from μ-mesonic atoms or high-energy electron scattering.

A.

539.164.74

8198. Multiple scattering of low-energy alpha particles in a gas. G. ALLEN, R. WEBELER AND S. BARILE. *Phys. Rev.*, **99**, *No.* 2, 556–8 (*July* 15, 1955).

Alpha-particles from a polonium source were slowed down and allowed to enter a cloud chamber containing a mixture of hydrogen, water and ethyl alcohol at pressures of 12·25 cm, 1·50 cm and 2·25 cm, respectively, during the sensitive time. Eighty-four sharp tracks of particles which stopped in the illuminated part of the chamber and which did not show any sharp bends due to single scattering were selected for study. Starting at the termini of the projected tracks, the angles between successive chords of 3 mm length were measured, the energies at the first three intersections of the chords being approximately 18, 45 and 85 keV. The magnitudes of the angles at which the tails of the distributions could be distinguished from the Gaussian parts were determined to be 10, 6 to 8 and 4°, respectively. The total standard deviations (which included the experimental error of 2·2°) for the Gaussian part of the distributions at these energies were 8·0°, 4·3° and 3·0°, respectively, so that the standard deviations due to multiple scattering were, respectively, 7·7, 3·7, and 2·0°.

A.

539.165

8199. The intensity of the soft second β-spectrum in ^{142}Pr. M. J. STERK, R. H. NUSSBAUM AND H. CERFONTAIN. Letter in *Physica*, **21**, *No.* 6, 541–2 (*June*, 1955).

Beta-γ coincidence measurements gave the results: intensity $2{\cdot}8 \pm 0{\cdot}4\%$; end-point $0{\cdot}70 \pm 0{\cdot}15$ MeV. No γ-rays other than the $1{\cdot}61 \pm 0{\cdot}02$ MeV ray could be detected.

J. J. WILKINS

539.165

8200. Scintillation spectrometer studies on the beta-activity of K^{40}. S. KONO. *J. Phys. Soc. Japan*, **10**, *No.* 7, 495–7 (*July*, 1955).

Scintillations from the crystal of potassium iodide activated with thallium iodide were used. The Kurie plot of the spectrum gave the forbidden shape, which was straightened from the end-point 1320 ± 20 keV down to well below 300 keV by the third forbidden tensor (or axial vector) correction factor. Measurement on the specific activity has also been carried out and resulted in the value $\lambda(\beta) = 5{\cdot}0 \pm 0{\cdot}2 \times 10^{-10}$ per year. This value is in good agreement with recent determinations.

A.

539.165

8201. Beta emitter Np^{238}. I. Beta spectroscopy. J. O. RASMUSSEN, H. SLÄTIS AND T. O. PASSELL. *Phys. Rev.*, **99**, *No.* 1, 42–7 (*July* 1, 1955).

The β-decay of Np^{238} has been studied with several β-spectrometers. In addition to the known conversion lines corresponding to transitions of energies now determined as 44·0, 102·2, 986 and 1 029 keV, new conversion lines, corresponding to transitions of 942 and 927 keV were found. These transitions indicate the presence of closely spaced levels at higher excitation energies. Intensities of conversion lines and β-groups were determined and compared with previous work. Fermi–Kurie plots confirm the allowed shape of the hard β-group (1·25 MeV) and give indication of complexity in the soft β-group (0·27 MeV). The energy deviations of the ground rotational band levels from the simple rotational energy formula are discussed.

A.

539.165

8202. Beta emitter Np^{238}. II. Scintillation spectroscopy and coincidence studies. J. O. RASMUSSEN, F. S. STEPHENS, JR, D. STROMINGER AND B. ÅSTRÖM. *Phys. Rev.*, **99**, *No.* 1, 47–55 (*July* 1, 1955).

The relative intensities of electromagnetic radiation from Np^{238}, determined by scintillation spectroscopy, set an upper limit for K capture of $K/\beta < 1\%$. On the basis of extensive scintillation counter coincidence measurements together with the β-spectroscopic results of the preceding abstract, two alternate decay schemes, differing only in minor detail, are proposed for Np^{238}. The levels of Pu^{238} involved are three close-lying ground rotational band members and a cluster of three levels near 1 MeV, two of which appear to belong to the same rotational band. Conversion coefficient determinations permit multipolarity assignment for a number of the γ-transitions and consequent spin and parity assignments for a number of excited states. Selection rules and other intensity rules involving the Bohr–Mottelson K-quantum numbers are tested, providing K-assignments for levels. There is a high degree of K-purity of those states where tests were possible. The question of possible "vibrational" character of the band near 1 MeV is discussed speculatively.

A.

539.165

8203. Observation of a 193-millimicrosecond metastable level in Pu^{239}. D. ENGELKEMEIR AND L. B. MAGNUSSON. *Phys. Rev.*, **99**, *No.* 1, 135–6 (*July* 1, 1955).

A metastable level in Pu^{239} with a half-life of 193 mμsec has been observed in the β-decay of Np^{239}. This metastable state is assigned to a level 382 keV above the ground state of Pu^{239}, and appears to de-excite by parallel 61- and 105-keV $E1$ γ-transitions.

A.

539.165 : 539.166

8204. Differential beta-gamma angular correlation in Cl^{38}. P. MACQ. *Bull. Acad. Roy. Belgique. Cl. Sci.*, **41**, *No.* 4, 467–73 (1955) In French.

This is a continuation of earlier measurements [see Abstr. 3063 (1955)] and shows that the angular correlation increases from 8 to 23% as the energy selected for the β-rays is increased from 1·22 to 2·5 MeV.

M. A. GRACE

539.165.2

8205. On beta-emission by lighter elements and determination of B_p, B_n. A. BASU (MITRA) AND S. BANERJEE. *Indian J. theor. Phys.*, **2**, *No.* 3, 95–110 (*Nov.*, 1954).

The elements in the region $Z = 0$ to $Z = 9$ have been studied with respect to binding energies and β-decay phenomenon. The experimentally determined β-decay energies in this region has been checked by different artificial reactions. In the second part of the paper, almost all the B_p and B_n

values in the above mentioned region are determined by means of Q values of artificial reactions. Curves plotted with B_p and B_n values thus determined, against Z or N, exhibit alternate increase and decrease for even and odd values of Z or N. A.

539.165.2

8206. Supermultiplets and spin dependent forces. R. W. KING. *Phys. Rev.*, **99**, *No.* 1, 67–70 (*July* 1, 1955).

A tentative explanation for a group of favoured negatron transitions from nuclei with $N-Z=3$ is proposed on the basis of a deviation from the supermultiplet formalism due to spin-dependent forces. The experimental evidence is exhibited and discussed. A.

539.165.2

8207. Superallowed beta transitions in the $N-Z=3$ series. E. FEENBERG. *Phys. Rev.*, **99**, *No.* 1, 71–5 (*July* 1, 1955).

A number of fast β-transitions have been found in the $N-Z=3$ series of radioactive nuclides. King has suggested (preceding abstract) that some of these transitions (for $A<27$) occur within the lowest [4 . . . 421] or [4 . . . 432] supermultiplet; hence are superallowed (or favoured). Matrix elements of $|\int\sigma|^2$ within the [21] and [32] supermultiplets are computed with the aid of two-way displacement operators on the eigenvalues of T_3, S_z and Y_{3z}. In the application to ${}_8O_{11}$ the only spin assignments consistent with an LS coupling interpretation of the fast transition are $I_i=5/2$, $I^*=\frac{3}{2}$ ($S^*=\frac{1}{2}$). These are the values favoured by the available experimental information. The jj coupling value of $|\int\sigma|^2$ for the ${}_8O_{11}$ transition is too large by a factor of five. A.

539.165.2

8208. Search for double beta decay in cadmium and molybdenum. R. G. WINTER. *Phys. Rev.*, **99**, *No.* 1, 88–92 (*July* 1, 1955).

Random Wilson cloud-chamber photographs of cadmium and molybdenum foils show that the double negatron half-life is greater than or equal to 1×10^{17} years in Cd^{116} and 3×10^{17} years in Mo^{100}, and that the double positron half-life is greater than or equal to 6×10^{16} years in Cd^{106} and 4×10^{18} years in Mo^{92}. The background appears to be primarily caused by Compton electrons and photoelectrons ejecting other electrons on their way out of the foil and by photons that suffer two Compton scatterings while traversing the foil. A.

539.165.2

8209. Energy available for beta decay of Nd^{150}. B. G. HOGG. *Phys. Rev.*, **99**, *No.* 1, 175 (*July* 1, 1955).

A study of the β-decay systematics at mass number 150 suggests that the mass-spectrographically determined $Nd^{150}-Sm^{150}$ difference of $4\cdot6\pm0\cdot8$ MeV is too high. If the recent value of $Pm^{150}-Sm^{150}=5\cdot3\pm0\cdot15$ MeV is used with a graphically estimated value of $4\cdot0$ MeV for the $Nd^{150}-Sm^{150}$ difference, then single β-decay of Nd^{150} is energetically impossible. A.

539.166

8210. Gamma-ray spectrum of polonium-209. E. H. DAGGETT AND G. R. GROVE. *Phys. Rev.*, **99**, *No.* 1, 1–2 (*July* 1, 1955).

A polonium sample was produced at Oak Ridge National Laboratory by the bombardment of bismuth targets with 20 MeV protons. The sample contained a mixture of the polonium isotopes of mass 208 and 209 with a negligible amount of the isotope of mass 210. Measurements were made of the isotopic ratio from the molecular spectrum and the α-activity was determined by calorimetry. The spectrum obtained with a NaI(Tl) crystal and pulse-height analyser showed the existence of γ-rays with energies of about 270, 570 and 865 keV. The 803 keV γ-ray of Po^{210} was not detected. This spectrum is attributed to Po^{209} since there is no γ-radiation from Po^{208}. The intensity of the 865 keV γ-ray relative to the γ-ray of a calibrated Po^{210} sample was estimated to be about $7\cdot5\times10^{-3}$ quanta per Po^{209} α-particle. Coincidence measurements between various pairs of γ-rays indicated that only the 270 and 570 keV quanta were in cascade and existed with about the same relative intensity as the 865 keV γ-ray. A.

539.166

8211. Gamma rays of tellurium-131 and tellurium-129. C. A. MALLMANN, A. H. W. ATEN, JR, D. R. BES AND C. M. DE MCMILLAN. *Phys. Rev.*, **99**, *No.* 1, 7 (*July* 1, 1955).

The γ-rays of Te^{131} and Te^{129} were investigated by means of a crystal spectrometer. A.

539.166

8212. Radiative capture of protons by N^{14}. S. BASHKIN, R. R. CARLSON AND E. B. NELSON. *Phys. Rev.*, **99**, *No.* 1, 107–11 (*July* 1, 1955).

The 277 keV resonance for the production of O^{15} in its $7\cdot61$ MeV state was excited by proton bombardment of a thick TiN target. A three-crystal, scintillation spectrometer resolved γ-rays of $5\cdot25\pm0\cdot1$ MeV, $6\cdot10\pm0\cdot1$ MeV and $6\cdot65\pm0\cdot15$ MeV, with relative intensities of 25 ± 6, 100 and 40 ± 10, respectively. Direct ground state transitions have a relative intensity of less than 5. The total radiative capture yield in nitrogen is $(2\cdot7\pm0\cdot6)\times10^{-11}$ reaction per proton. The intensity of $6\cdot10$ MeV radiation to $5\cdot25$ MeV radiation, measured with a single-crystal spectrometer, is $7\pm3\%$ lower at 90° to the beam than at 0°. The asymmetry eliminates pure s-wave capture. It is concluded that the capture state has spin 5/2 and decays by dipole emission to the first three excited states of O^{15}. A.

539.166

8213. Gamma-ray yields from Coulomb excitation. P. H. STELSON AND F. K. MCGOWAN. *Phys. Rev.*, **99**, *No.* 1, 112–26 (*July* 1, 1955).

The yields of γ-rays resulting from Coulomb excitation have been measured for the elements Ta, Au, Pt, Tl, Pb, Th, W, Hf, Ag, Pd, Rh and Mo. The yields of the 137, 166 and 303 keV γ-rays in Ta and the (277 + 273) and 550 keV γ-rays in Au were studied as a function of proton energy. No significant deviation from the predictions of the semiclassical theory of Alder and Winther was observed. Reduced transition probabilities for $E2$ and $M1$ transitions have been obtained from the γ-ray yields. In four cases these values may be compared to values obtained from direct half-life measurements. The good agreement indicates that the absolute cross-section for Coulomb excitation is correctly given by the theory. Nuclear

distortions based on the observed $E2$ transition probabilities are compared to those obtained from the observed excitation energies. A.

539.166

8214. Angular distribution of gamma rays from Coulomb excitation. F. K. McGowan and P. H. Stelson. *Phys. Rev.*, **99**, *No.* 1, 127–34 (*July* 1, 1955).

The angular distributions of γ-rays with respect to the incident proton beam on a thick target have been measured for γ-rays following Coulomb excitation in $Pt^{194,196}$, Au^{197}, Ta^{181}, $Ag^{107,109}$, Pd^{106}, Pd^{108}, Pd^{110} and Rh^{103}. The observed angular distributions deviate considerably from the semiclassical theory of angular distributions of γ-rays following Coulomb excitation given by Alder and Winther. Empirical curves of energy-dependent coefficients $a_\gamma(\xi)$ for a thick target are obtained from the results for $Pt^{194,196}$ and Pd^{106}. With these empirical coefficients, information on the spin sequences and the character of the γ-transitions are deduced from the angular distribution measurements in the odd mass nuclei. The spin sequences are as follows: $7/2(E2)3/2$ and $5/2(E2 + M1)3/2$ with $\delta_\gamma = -0{\cdot}75$ (where $\delta^2_\gamma = E2/M1$) for the 550 and 277 keV transitions, respectively, in Au^{197}; $11/2(E2)7/2$ and $11/2(E2 + M1)9/2$ with $\delta_\gamma = 0{\cdot}51$ for the 303 and 166 keV transitions, respectively, in Ta^{181}; $5/2(E2)1/2$ and $3/2(E2 + M1)1/2$ with $\delta_\gamma = -0{\cdot}19$ or $-1{\cdot}14$ for the 427 and 325 keV transitions, respectively, in $Ag^{107,109}$; and $5/2(E2)1/2$ and $3/2(E2 + M1)1/2$ with $\delta_\gamma = -0{\cdot}18$ or $-1{\cdot}17$ for the 365 and 305 keV transitions, respectively, in Rh^{103}. A.

539.166

8215. Perturbed gamma-gamma directional correlation in Cd^{114}. S. C. Daubin and D. R. Hamilton. *Phys. Rev.*, **99**, *No.* 3, 683–5 (*Aug.* 1, 1955).

The directional correlation of the 722–556 keV γ-γ cascade in Cd^{114} following K-capture in In^{114} has been observed as a function of physical and chemical state of the source. Dry $InCl_3$ and frozen solutions thereof are consistent in giving an attenuation factor $0{\cdot}77 \pm 0{\cdot}08$ in the anisotropy. The lifetime of the intermediate state is found to be $\leqslant 2{\cdot}3 \times 10^{-10}$ sec. Assuming that the perturbing interaction is electric and making a crude estimate of an upper limit in the electric field gradient at the nucleus, one obtains a quadrupole moment $|Q| \geqslant 0{\cdot}4 \times 10^{-24}$ cm^2 for the intermediate state of the cascade. A.

539.166

8216. Angular correlation of the gamma rays of Ba^{134}. M. G. Stewart, R. P. Scharenberg and M. L. Wiedenbeck. *Phys. Rev.*, **99**, *No.* 3, 691–4 (*Aug.* 1, 1955).

The angular correlations have been measured between the following pairs of γ-rays from Ba^{134}: 605 keV–797 keV, 1 368 keV–605 keV and 570 keV–605 keV. These measurements indicate that the spins of the states associated with these γ-rays are 4, 4, 2, 0. The 605, 797 and 1 368-keV γ-rays are pure quadrupole while the 570 keV γ-ray is a mixture of 94% quadrupole and 6% dipole. A.

539.166

8217. Gamma rays from the deuteron bombardment of Be^9, B^{10}, N^{14}, and F^{19}. R. D. Bent, T. W. Bonner, J. H. McCrary, W. A. Ranken and R. F. Sippel. *Phys. Rev.*, **99**, *No.* 3, 710–18 (*Aug.* 1, 1955).

A magnetic lens pair spectrometer has been used to study the radiations produced by the bombardment of certain light nuclei with deuterons from a Van de Graaff accelerator. Gamma-rays from the bombardment of Be^9 with 2·5-MeV deuterons were observed at $6{\cdot}00 \pm 0{\cdot}06$, $5{\cdot}10 \pm 0{\cdot}1$ and $4{\cdot}52 \pm 0{\cdot}1$ MeV. At 3·85-MeV bombarding energy no lines were observed between 6·5 and 8·0 MeV with an intensity as great as 5% of that of the 6·0 MeV line. Gamma-rays from the bombardment of B^{10} with 2·0 MeV deuterons were observed at $8{\cdot}93 \pm 0{\cdot}04$, $8{\cdot}57 \pm 0{\cdot}04$, $7{\cdot}30 \pm 0{\cdot}03$, $6{\cdot}75 \pm 0{\cdot}03$, $6{\cdot}50 \pm 0{\cdot}03$, $5{\cdot}03 \pm 0{\cdot}03$, $4{\cdot}73 \pm 0{\cdot}03$ and $4{\cdot}49 \pm 0{\cdot}05$ MeV. Gamma-rays from the bombardment of N^{14} with 4·0 MeV deuterons were observed at $10{\cdot}73 \pm 0{\cdot}08$, $10{\cdot}04 \pm 0{\cdot}04$, $9{\cdot}13 \pm 0{\cdot}06$, $8{\cdot}33 \pm 0{\cdot}04$, $7{\cdot}31 \pm 0{\cdot}04$, $6{\cdot}81 \pm 0{\cdot}04$, $6{\cdot}33 \pm 0{\cdot}05$, $6{\cdot}12 \pm 0{\cdot}06$ and $5{\cdot}26 \pm 0{\cdot}04$ MeV. Gamma-rays from the bombardment of F^{19} with 3·6 MeV deuterons were observed at $11{\cdot}51 \pm 0{\cdot}2$, $10{\cdot}61 \pm 0{\cdot}1$, $9{\cdot}97 \pm 0{\cdot}1$ and $9{\cdot}34 \pm 0{\cdot}1$ MeV. All the energies of γ-rays given above are corrected for Doppler shifts. A comparison is made for some of the reactions of the relative (d, p) and (d, n) cross-sections. A.

539.166 : 539.172.4

8218. Energy spectrum of gammas from gross fission products. J. Moteff. *Nucleonics*, **13**, *No.* 5, 28–31 (*May*, 1955).

The total γ-ray power output from reactor fission products is deduced as a function of time after shutdown for various operating periods. Decay curves are also given for 7 separate energy groups, from 100 keV to 3 MeV. The basis of the calculations is a detailed summation of the individual γ-radiations from 24 fission-product isotopes. L. R. SHEPHERD

539.166 : 539.172.4

8219. Gamma rays from thermal-neutron capture. P. S. Mittelman and R. A. Liedtke. *Nucleonics*, **13**, *No.* 5, 50–1 (*May*, 1955).

Photons emitted per 100 captures in energy intervals 0–1, 1–3, 3–5, 5–7 and 7 MeV are tabulated for a large number of elements. Three types of spectra are classified, namely:—predominantly ground-state transitions, distinct line spectra with transitions between many levels and unresolved spectra from heavy elements with high level density.

L. R. SHEPHERD

539.166.08 : 537.531

8220. Dosimetry of X- and γ-rays by alkali-halide crystals containing U-centres. W. G. Burns and R. Lockyer. *J. sci. Instrum.*, **32**, *No.* 8, 316–19 (*Aug.*, 1955).

A crystal dosimeter is described. The sensitive element is a crystal of potassium chloride containing potassium hydride in solid solution at a concentration of $5{\cdot}5 \times 10^{18}$ molecules potassium hydride per cm^3, and this becomes coloured due to the formation of the F-band on irradiation. The colour is stable in the dark up to 50°C, and fades in the light sufficiently slowly for a reasonably accurate estimation of the dose to be made. The preparation of the material and tests on its sensitivity, temperature dependence,

energy dependence and rate of dosing, are described. Using a spectrophotometer, doses from ten to many thousand röntgen of γ-rays have been measured. This type of dosimeter has the advantage over the radiophotoluminescent type that a visible coloration is produced enabling doses of 75 r and upwards to be estimated roughly without a special reader. A simple, battery-operated reader enabling field measurement of doses from 20 to 600 r has been made. Its characteristics make the dosimeter very suitable for a personnel flash dosimeter. A.

539.166.74

8221. Scattering of Co^{60} γ-radiation by the electric field of nuclei. P. EBERHARD AND L. GOLDZAHL. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 24, 2304–6 (*June* 13, 1955) In French.

An extension and confirmation of previous measurements [see Abstr. 4923 (1955)] on the coherent scattering by Pb, Sn and U. M. A. GRACE

539.166.74

8222. Bipartition angles for Compton scattering by free electrons. H. M. CHILDERS AND J. D. GRAVES. *Phys. Rev.*, **99,** *No.* 2, 343–5 (*July* 15, 1955).

In the Compton scattering of free electrons, the bipartition angles for the number of scattered photons, the number of secondary electrons, the energy of scattered photons, and the energy of the secondary electrons have been tabulated in terms of the incident photon energy from 10 keV to 10 MeV. (The bipartition angle for a quantity is the half-angle of the cone into which one-half of that quantity is scattered.) The average scattered photon energy and the average Compton electron energy have also been computed. In addition, a relation is given for the probability that the Compton electron energy will fall into the energy interval (E_1, E_2). A.

539.166.83

8223. The internal conversion electron spectrum of ^{241}Am. J. F. TURNER. *Phil. Mag.*, **46,** 687–700 (*July*, 1955).

Observations of the internal conversion electron spectrum of Am^{241} and of $e^- - e^-$ coincidences, using a pair of magnetic lens spectrometers, afford evidence in support of the level scheme in Np^{237} derived from Asaro's α-particle observations, except that no indication of transitions to the ground state is found. Information on the half-lives and multipole orders of certain of the γ-transitions in Np^{237} is obtained. A.

539.166.83

8224. The fluorescence yields of the *L* levels of bismuth. M. A. S. ROSS, A. J. COCHRAN, J. HUGHES AND N. FEATHER. *Proc. Phys. Soc. A*, **68,** *Pt* 7, 612–24 (*July*, 1955).

This paper is a supplement to the discussion by Kinsey [Abstr. 3426–7 (1949)] of the fluorescence yields of the *L* sub-shells in the heavy elements; it suggests the use of experimental measurements other than those which he discussed for the calculation of these quantities. New observations are reported and collated with existing information. The fluorescence, Auger and Coster–Kronig yields of Bi are re-calculated. Suggestions are made about further experimental work. The numerical results are, for the fluorescence yields of Bi, $\omega_1 = 0{\cdot}12 \pm 0{\cdot}01$, $\omega_2 = 0{\cdot}32 \pm 0{\cdot}04$, $\omega_3 = 0{\cdot}40 \pm 0{\cdot}05$, for the Auger yields $a_1 = 0{\cdot}11 \pm 0{\cdot}03$, $a_2 = 0{\cdot}62 \pm 0{\cdot}14$, $a_3 = 0{\cdot}60 \pm 0{\cdot}05$, and for the Coster–Kronig yields $f_{12} = 0{\cdot}19 \pm 0{\cdot}05$, $f_{13} = 0{\cdot}58 \pm 0{\cdot}05$, $f_{23} = 0{\cdot}06 \pm 0{\cdot}14$. A discussion is added on some aspects of the radioactive disintegration of RaD. A.

539.167.3

8225. Production and physical properties of radioisotopes. C. J. BAKKER. *Reĉueil Trav. chim. Pays-Bas*, **74,** *No.* 5, 281–93 (*May*, 1955).

Production in nuclear reactors and in cyclotrons is discussed. The types of nuclear reactions involved are mentioned, and the importance of the cyclotron as a complement to the nuclear reactor is noted. Examples of disintegration schemes of radioisotopes are given. The loss of energy of β- or γ-rays during their passage through matter is briefly discussed. The precautions necessary when working with radioisotopes are mentioned shortly. A.

539.169 : 621.319.33

8226. Output voltage and current of the nuclear converter. O. RIEDEL. *Z. angew. Phys.*, **7,** *No.* 6, 265–71 (1955) In German.

Discusses the load characteristics and efficiency of a generator, consisting of a β-source surrounded by a vacuum insulated anode, for the cases of spherical, cylindrical and planar geometry. Results are presented for a monoenergetic source as well as for a Sr^{90} source, and are shown to be in accord with a particular measurement reported by Linder and Christian [Abstr. 428 (1953)]. The effect of secondary electrons produced at the anode is not significant provided that this is constructed of a low atomic number material. It is concluded that the poor regulation, and the necessity for shielding, will greatly limit the scope for practical application.

E. A. ASH (R)

NUCLEAR REACTIONS 539.17

539.172

Nuclear reactions due to cosmic rays. *See also under* "Cosmic rays." Decimal classification 537.591.8

539.172

8227. Nuclear disintegration, connected with heavy unstable particles. I. M. GRAMENITSKIĬ, E. A. ZAMCHALOVA, M. I. PODGORETSKIĬ, M. I. TRET'YAKOVA AND M. N. SHCHERBAKOVA. Letter in *Zh. éksper. teor. Fiz.*, **28,** *No.* 5, 616–17 (1955) *In* Russian.

The average number of grey and black rays from stars containing Y, Λ, K and τ mesons is analysed; for τ mesons it is found to be significantly less than for the others. Possible theoretical implications are discussed. G. E. BROWN

539.172

8228. Some aspects of the nuclear capture of hyperons and *K*-mesons. M. W. FRIEDLANDER, Y. FUJIMOTO, D. KEEFE AND M. G. K. MENON. *Nuovo Cimento* (*Ser.* 10) **2,** *No.* 1, 90–9 (*July*, 1955).

Some predictions are made concerning the characteristics of the interactions produced by the nuclear capture of K^-- and Y^--particles. It is assumed

that the capture reaction is the inverse of the "associated production mechanism." A comparison is made between these predictions and the experimental data. The significant conclusions are: (i) the capture process sometimes involves two or more nucleons rather than a single nucleon; (ii) in view of the possible existence of Σ^0-particles and their rapid transformation to Λ^0-particles, the observation of Λ^0-particles as end products of a capture process does not necessarily indicate that they were produced in the initial reaction; (iii) there appears to be an absence of μ-mesons of $\sim$120 MeV; this might indicate the production of an Σ^0-particle instead of a Λ^0-particle in the initial reaction or that the capture involves two or more nucleons; (iv) the available observations on capture stars are consistent with the general features of the theory of Gell-Mann and Pais. A.

539.172.11

8229. On the nuclear interaction of 350 MeV α-particles. G. Quareni and G. T. Zorn. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1282–4 (*June*, 1955).

The 200 and 400 μ emulsions used were exposed to the 385 MeV α-particle beam of the Berkeley cyclotron. The mean free path for nuclear interaction is $(80 \pm 6{\cdot}75)$ g/cm^2. Details are given of the size distribution and angular distribution of prongs for 306 events. H. ELLIOT

539.172.11

8230. The radiative capture of alpha particles in ^{14}N. P. C. Price. *Proc. Phys. Soc. A*, **66**, *Pt* 7, 553–8 (*July*, 1955).

The $N^{14}(\alpha, \gamma)F^{18}$ reaction has been examined from 1·2 to 2·2 MeV bombarding energy. Two narrow resonances have been found; their positions have been measured, and upper-limits obtained for their total widths. The cascade schemes at each resonance have been partly elucidated, and the position of another level involved in these cascades has been measured. The partial radiation widths of these resonances have been determined, except for a statistical factor. Some of the angular distributions have been studied, and conclusions have been drawn about the possible values of the spins and parities of the levels concerned. A.

539.172.13

8231. Nuclear reactions of copper with various high-energy particles. G. H. Coleman and H. A. Tewes. *Phys. Rev.*, **99**, *No.* 1, 288–9 (*July* 1, 1955).

A study of the spallation of copper by 90-MeV neutrons, 90-MeV protons, 190-MeV protons, and 190-MeV deuterons has been made. Radiochemical methods have been employed to determine absolute cross-sections for the production of a number of nuclides produced by the interaction of these high-energy particles with copper. A.

539.172.13

8232. Scarcity of low-energy levels of ^{8}Be appearing in two boron reactions. R. E. Holland, D. R. Inglis, R. E. Malm and F. P. Mooring. *Phys. Rev.*, **99**, *No.* 1, 92–5 (*July* 1, 1955).

A careful search is made for evidence of possible excited states in ^{8}Be in the reactions $B^{11}(p, \alpha)Be^8$ and $B^{10}(d, \alpha)Be^8$, by magnetic momentum analysis at a variety of angles and bombarding energies. In spite of observing the region corresponding to 3 to 8 MeV several times independently under different conditions, with several thousand counts per point on points spaced only about 100 keV apart, no indication was found of any of the states in this region reported by others on the basis of poorer statistics, mostly in other reactions. Each α-particle spectrum observed consists of a sharp ground-state peak and a broad peak of the α-particles giving rise to the well-known 3 MeV excited state of ^{8}Be superposed on a continuous background from the break-up of this state and from three-particle break-up. Peaks observed near the equivalent of 10 and 11 MeV in ^{8}Be are identified as arising from a target impurity. A.

539.172.13

8233. Energy levels in ^{9}Be. L. L. Lee, Jr, and D. R. Inglis. *Phys. Rev.*, **99**, *No.* 1, 96–8 (*July* 1, 1955).

Magnetic analysis of the reaction $B^{11}(p, \alpha)Be^9$ at three angles verifies the existence of rather broad excited states of ^{9}Be at 1·75 and 3·02 MeV, the peaks of which almost vanish at 90° where the original investigation showed only the well-known 2·43 MeV state. A.

539.172.13

8234. Elastic scattering of protons by ^{19}F. T. S. Webb, F. B. Hagedorn, W. A. Fowler and C. C. Lauritsen. *Phys. Rev.*, **99**, *No.* 1, 138–45 (*July* 1, 1955).

The differential cross-section for the elastic scattering of protons by F^{19} has been measured for proton energies from 550 to 1 800 keV at centre-of-mass angles of 90, 125·3 and 159·8 degrees and for proton energies from 1 300 to 1 500 keV at 53·2, 60, 70, 80, 100, 110 and 136 degrees. Marked scattering anomalies were observed for proton energies near 669 (1^+), 843 (0^+), 873 (2^-), 935 (1^+), 1 346 (2^-), 1 372 (2^-), 1 422 (1^+) and 1 700 keV. The indicated spin and parity assignments for the corresponding levels in ^{20}Ne are required by the results of this experiment or are consistent with them. Observations of the elastic scattering have also been made in the regions of 340 and 480 keV at 159·8 degrees, and no anomaly was observed in either case. The ambiguity in the choice of Γ_p/Γ has been resolved for several of the ^{20}Ne levels. An approximate method of correcting the observed cross-sections for the effects of finite energy resolution has been developed, and the relative stopping cross-section for protons in lithium fluoride has been measured for proton energies from 400 to 1 600 keV. A.

539.172.13

8235. Analysis of the elastic scattering of protons from ^{19}F. E. U. Baranger. *Phys. Rev.*, **99**, *No.* 1, 145–9 (*July* 1, 1955).

An analysis of the anomalies in the elastic scattering cross-section of protons on F^{19} has been carried out. The assignments 1^+ for the resonances at 669, 935 and 1 422 keV, and 0^+ for the resonance at 843 keV, are required by the results of the experiment. The assignment of the resonances at 873, 1 348 and 1 374 keV is 2^-, with 1^- not excluded by these data alone. Unique values of the partial widths are

determined for these resonances and several others in this energy range. Reduced widths are given for the various particle reactions which are observed. A.

539.172.13

8236. Bombardment energy and fission product yield pattern for protons on natural uranium and U^{235}. W. H. Jones, A. Timnick, J. H. Paehler and T. H. Handley. *Phys. Rev.*, **99**, *No.* 1, 184–7 (*July* 1, 1955).

Relative fission yields of ten nuclides produced by proton-induced fission of natural uranium and U^{235} were determined at several proton energies in the range 12 to 20 MeV. The expected trend toward symmetric fission at increased energies is observed. A statistical relation is used to correlate this shift in fission symmetry with the excitation energy of the compound nucleus. A.

539.172.13

8237. Disintegration of aluminum by protons in the energy range 0·4 to 3·0 BeV. G. Friedlander, J. Hudis and R. L. Wolfgang. *Phys. Rev.*, **99**, *No.* 1, 263–8 (*July* 1, 1955).

Excitation functions for the production of Na^{24}, Na^{22}, F^{22}, O^{18}(?), N^{13}, C^{11}, and Be^{7} in proton bombardments of Al have been measured from 0·4 to 3·0 BeV. The formation cross-sections have strikingly small energy dependence, and this feature is discussed in the light of possible energy transfer mechanisms. The absolute cross-section values are based on a calibration method (suggested by A. Turkevich) which is discussed. It is based on measurements of gross radioactivity in copper irradiated at various energies and on the assumption that the fraction of inelastic collisions with copper nuclei that lead to radioactive products is independent of proton energy from 0·3 to 3 BeV. The validity of this assumption is examined. A.

539.172.13

8238. (p,pn) and $(p,2n)$ cross sections in medium weight elements. B. L. Cohen and E. Newman. *Phys. Rev.*, **99**, *No.* 3, 718–23 (*Aug.* 1, 1955).

The quantity F_p/F_n, the ratio of probabilities for proton and neutron emission from nuclear reactions in the statistical region, is determined from measurements of (p, pn) and $(p, 2n)$ cross-sections induced by 21·5-MeV protons bombarding nuclei of masses 48 to 71. The results are then compared with determinations of F_p/F_n from reactions induced by lower-energy protons and 14-MeV neutrons. Both the absolute values of F_p/F_n and their variation with bombarding energy are very difficult to explain by usual nuclear reaction theories. A.

539.172.13

8239. $(p,pn) + (p,2n)$ and $(p,2p)$ cross sections in medium weight elements. B. L. Cohen, E. Newman and T. H. Handley. *Phys. Rev.*, **99**, *No.* 3, 723–7 (*Aug.* 1, 1955).

Several $(p,pn) + (p,2n)$ and $(p,2p)$ cross-sections of nuclei of mass 19 to 69 were measured with 21·5-MeV incident protons. For all elements with mass less than 55 and for Ni^{58}, the $(p,pn) + (p,2n)$ cross-section is very much less than the total reaction cross-section. Detailed analysis of the data indicates that this is largely due to competition from $(p,2p)$ reactions. The conclusion (preceding abstract) that the ratio of probabilities for proton and neutron emission is much larger than expected seems to be confirmed and extended to lighter nuclei. A.

539.172.13 : 539.166

8240. Gamma-rays from the inelastic scattering of protons by nitrogen 14. J. Thirion and R. Barloutaud. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 22, 2136–8 (*June* 1, 1955) In French.

Three resonances ($E_1 = 3{\cdot}92 \pm 0{\cdot}03$, $E_2 = 3{\cdot}99 \pm 0{\cdot}03$ and $E_3 = 4{\cdot}95 \pm 0{\cdot}04$ MeV) were observed in the inelastic scattering of protons by N (2·3 MeV excited state) for $3 < E_p < 5$ MeV. Measurements of the γ-ray energy in the forward and backward (relative to the proton beam) directions showed a Doppler effect due to the motion of the nuclei, implying a life-time of the excited state $<2\times10^{-13}$ sec. The bearing of this on the β-particle $\frac{1}{2}$-life of C^{14} is discussed. A. O. Stanesby

539.172.13 : 539.172.4

8241. Polarization in nucleon scattering at various energies. R. Wilson. *Phil. Mag.*, **46**, 769–82 (*July*, 1955).

The polarization of nucleons elastically scattered from nuclei is discussed on the optical model. Analytical formulae are used to illustrate the differences between various approximations. A uniform spin-orbit potential is shown to be at variance with experiment, unless the magnitude varies with the nuclear radius, and it is shown that the polarization may change sign at an energy close to that for which the total cross-section is a maximum. A.

539.172.13 : 539.172.4

8242. The selection of potentials in nucleon–nuclear scattering problems. G. C. Morrison, H. Muirhead and P. A. B. Murdoch. *Phil. Mag.*, **46**, 795–9 (*July*, 1955).

It is shown that the magnitudes of the real and imaginary potentials employed in nucleon–nuclear scattering problems may be qualitatively predicted with the aid of data on free nucleon–nucleon scattering, and a Fermi gas model of the nucleus. A.

539.172.13

8243. On the excitation function of the reaction $Ne^{20}(d,p)Ne^{21}$. S. Gorodetzky, T. Muller and M. Port. *C.R. Acad. Sci.* [*Paris*] **240**, 2224–6 (*June* 6, 1955) In French.

The excitation function for the reaction leading to the first and second excited states of Ne^{21} shows peaks at a deuteron energy corresponding to an excitation energy of 12·1 MeV in the compound nucleus Na^{22}. The reaction leading to the third excited state shows no peak and the ground state transition was not examined. J. M. Cassels

539.172.13

8244. The 1 million volt particle accelerator at Lyons, used as a neutron generator. P. Leuba, R. Salin, J. Thibaud and P. Verzaux. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 24, 2308–10 (*June* 13, 1955) In French.

See Abstr. 1911 (1955). With a heavy hydrogen source a deuteron beam of 60 to 70 μA is obtained below 500 keV, falling to 40 μA above 800 keV. Neutrons produced in beryllium are studied using BF^3 counters, activation of silver, and photographic

plates. The departure from linearity of a log-yield against energy curve at the higher energies is attributed partly to defocusing in the accelerator, and perhaps also to a resonance near 1 MeV. J. S. BELL

539.172.13

8245. The reaction $^{11}B(d,n)^{12}C$. A. WARD AND P. J. GRANT. *Proc. Phys. Soc. A*, **68**, *Pt* 7, 637–43 (*July*, 1955).

Using scintillation-counter detection and pulse-height analysis, the angular distributions of the neutron groups from the reaction $B^{11}(d,n)C^{12}$ leading to the ground state and first excited state of C^{12}, have been determined at a deuteron bombarding energy of 600 keV. The results are compared with those predicted by the stripping theory and with those expected if the reaction proceeds by compound nucleus formation. The stripping mechanism appears to be important even at low bombarding energies for the ground-state group, but for the excited state the interpretation is less certain. A.

539.172.13

8246. A note on the branching ratio of the D–D reactions. K. G. MCNEILL. *Phil. Mag.*, **46**, 800–4 (*July*, 1955).

Recently two papers have been published [Abstr. 3582 (1953), 1195 (1955)] which contain results on the branching ratio of the two D–D reactions at variance with those of earlier workers [Abstr. 4715 (1951), 4937 (1954)]. In this note it is suggested that this disagreement is due to the acceptance by the latter of incorrect values for the angular asymmetries of the reactions. On this assumption the experimental results have been recalculated using more recent data on the angular distribution, and it is found that the corrected values are in agreement with those of the more recently published results; that is, the 90° c.m. branching ratio, $\sigma D(d,n)He^3/\sigma D(d,p)H^3$, does not vary with deuteron energy, but the ratio of the total cross-sections rises from 1·01 at 14 keV to 1·20 at 466 keV deuteron energy. A.

539.172.13

8247. Disintegrations of some light elements studied by the photographic method. P. CUER, D. MAGNAC-VALETTE AND G. BAUMANN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 19, 1880–2 (*May* 9, 1955) In French.

Several new reactions have been discovered by observations on the stars caused by tritons in nuclear emulsion loaded with lithium. The reaction $Li^6 + H^3 \rightarrow {}^*Li^8 + H^1$ has been observed to give an excited state at 0·7 ± 0·2 MeV in Li^8. Two examples of the reaction $Li^7 + H^3 \rightarrow He^4 + {}^*He^6$ have been observed, giving excited states of He^6 at 5·6 and 1·6 MeV. Three disintegrations of carbon nuclei have been found: two of the type, $C^{12} + H^3 \rightarrow He^4 + B^{11}$ and one of the type, $C^{12} + H^3 \rightarrow H^1 + {}^*C^{14}$, $^*C^{14}$ being excited in its state at 6·1 MeV. The above reactions giving He^6 and B^{11} as residual nuclei have cross-sections of less than 10^{-2} barn. The reaction $C^{12} + H^3 \rightarrow H^1 + C^{14}$ which should very easily be seen in the emulsion has not in fact been observed and the cross-section is hence determined to be less than 5×10^{-3} barn for triton energies of 1–3 MeV.

D. J. PROWSE

539.172.3

8248. Range of recoil, in phosphorus, of P^{30} obtained by the reaction $P^{31}(\gamma,n)P^{30}$. Application to the preparation of carrier-free P^{30}. J. PAULY AND P. SÜE. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 23, 2226–8 (*June* 6, 1955) In French.

Suspensions of red phosphorus in tetraline were irradiated by a 22 MeV betatron, and up to 20% of the P^{30} produced was recovered from the liquid phase. A recoil range ~0·25 μ is deduced. See also Abstr. 8255 (1955). J. J. WILKINS

539.172.3

8249. Cross-sections near threshold for charged photo-pions from deuterium. D. CARLSON-LEE, G. STOPPINI AND L. TAU. Letter in *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 162–4 (*July*, 1955).

Study of the reactions

$$\gamma + D \begin{cases} \nearrow (n,n) + \pi^+ \\ \searrow (p,p) + \pi^- \end{cases}$$

has been continued using stripped emulsions. Direct determinations of the differential cross-sections of the two single processes, as well as the π^-/π^+ ratio, have been made, and are given in a table. The total photodisintegration cross-section, in the energy range 150–200 MeV, is given as $48 \pm 14\times10^{-30}$ cm^2.

P. ROTHWELL

539.172.3

8250. Photoprotons from oxygen. B. M. SPICER. *Phys. Rev.*, **99**, *No.* 1, 33–6 (*July* 1, 1955).

The cross-section and angular distribution of the $O^{16}(\gamma,p)N^{15}$ reaction have been obtained for photon energies between 13·5 and 18·7 MeV, i.e. below the expected position of the giant resonance. The angular distribution indicated that the reaction proceeded predominantly through electric quadrupole or magnetic dipole absorption of photons, even though electric dipole transitions are allowed by isotopic spin selection rules. Suggestions are made regarding this forbiddenness of electric dipole absorption. A.

539.172.3

8251. Photofission of U^{238}. L. KATZ, T. M. KAVANAGH, A. G. W. CAMERON, E. C. BAILEY AND J. W. T. SPINKS. *Phys. Rev.*, **99**, *No.* 1, 98–106 (*July* 1, 1955).

Chemical separation of the products resulting from photofission at various maximum bremsstrahlung energies E_0 of U^{238} serve to define the 3-dimensional yield surface $S(Y,A,E_0)$. An analysis of this surface by the photon difference method established the 3-dimensional photofission cross-section surface $S(\sigma,A,h\nu)$. The peak-to-valley cross-section ratio (asymmetric to symmetric fission) is examined in some detail and the results are combined with high-energy photofission data from the literature to extend calculations and analysis to 300 MeV. A.

539.172.3

8252. Photodeuteron/photoproton yield from sulfur. L. S. RING, JR. *Phys. Rev.*, **99**, *No.* 1, 137–8 (*July* 1, 1955).

An investigation of the relative deuteron/proton yield from sulphur, produced by irradiation with a 65 MeV synchrotron, was made by employing a

12 in., helium-filled, magnetic cloud chamber as the means of detection. The average curvature and the range of each acceptable track were measured and were used to find an experimental mass histogram that provided a clear indication of proton and deuteron groups. Analysis of the mass histogram produced a ratio of deuterons to protons of $0{\cdot}19 \pm 0{\cdot}04$. It is estimated that the corresponding ratio for an infinitesimally thick target is $0{\cdot}15 \pm 0{\cdot}04$. A.

539.172.3

8253. Elastic photoproduction of π^0 mesons from deuterium. B. WOLFE, A. SILVERMAN AND J. W. DEWIRE. *Phys. Rev.*, **99**, *No.* 1, 268–72 (*July* 1, 1955).

The average differential cross-section for the reaction $\gamma + d = \pi^0 + d$ has been measured for photons between 250 and 300 MeV at four angles. A difference measurement with deutero-paraffin and normal paraffin targets was employed. The recoil deuterons were detected by a counter telescope which discriminated against protons by recording the product of the energy and the specific ionization loss of the particles. The reaction was further identified by demanding a coincidence between the deuteron pulse and a pulse from a photon counter placed at an angle corresponding to the direction of the π^0. The values of the differential cross-section for various angles of the π^0 in the laboratory system are as follows:

$\theta(\pi^0)$	$d\sigma/d\Omega$ (10^{-30} cm^2/steradian)
76°	$4{\cdot}2 \pm 0{\cdot}6$
93°	$3{\cdot}2 \pm 0{\cdot}5$
110°	$2{\cdot}5 \pm 0{\cdot}4$
130°	$1{\cdot}2 \pm 0{\cdot}3$

The stated errors are the standard statistical errors and apply to the relative cross-sections at the various angles. The absolute cross-section scale is subject to an experimental error of 25%. The measured cross-sections are in agreement with theoretical calculations based on the impulse approximation, with the assumption of equal amplitudes for π^0 production from the proton and neutron and constructive interference. A.

539.172.3

8254. Elastic photoproduction of π^0 mesons from deuterium at 270 MeV. H. L. DAVIS AND D. R. CORSON. *Phys. Rev.*, **99**, *No.* 1, 273–7 (*July* 1, 1955).

The cross-section for the process $\gamma + d \rightarrow \pi^0 + d$ has been measured by observing the recoil deuteron. The recoil was first analysed by a uniform magnetic field and then allowed to pass through a nuclear emulsion. The following values were obtained for the absolute cross-section for π^0 production at a photon energy of 270 MeV and π^0 laboratory angles 124° and 168°: $d\sigma/d\Omega(124°) = 3{\cdot}2 \pm 0{\cdot}9\,\mu$b/steradian and $d\sigma/d\Omega(168°) = 1{\cdot}3 \pm 0{\cdot}5\,\mu$b/steradian. The fact that the cross-section is the same order of magnitude as the cross-section for the production of π^0's from hydrogen is evidence that constructive interference exists between the π^0 production from the proton and the π^0 production from the neutron. On the basis of approximate theories of meson production from deuterium, a lower limit is deduced for the isotropic part of the angular distribution of π^0's photoproduced from hydrogen. A.

539.172.4

8255. Range of the isotopes P^{32} and S^{35} recoiling following the nuclear reactions $S^{32}(n,p)P^{32}$ and $S^{34}(n,\gamma)S^{35}$. J. PAULY. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 25, 2415–17 (*June* 20, 1955) In French.

See also Abstr. 8248 (1955). Suspensions of sulphur in water were irradiated with neutrons. Up to 75% of the P^{32} and $\sim 0{\cdot}26\%$ of the S^{35} produced was recovered from the liquid phase. Recoil ranges up to $0{\cdot}65\,\mu$ for P^{32} and $\sim 0{\cdot}003\,5\,\mu$ for S^{35} are deduced. J. J. WILKINS

539.172.4

8256. A theoretical investigation of nuclear reactions with neutrons. M. CINI AND S. FUBINI. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 75–89 (*July*, 1955).

A theory of the interaction of neutrons with complex nuclei is developed with the aim of obtaining a cross-section averaged over the resonances, to be compared with the results of the phenomenological model proposed by Feshbach, Porter and Weisskopf [Abstr. 524 (1955)]. It is shown what kind of assumptions have to be introduced in order that the compound nucleus formation gives rise to an absorption of the incident beam, irrespective of what happens after the compound nucleus decay. The problem is reduced to the determination of the complex index of refraction of an indefinite nuclear matter, taking properly into account the effect of the Pauli principle. Subsequently this index of refraction has to be introduced into a one-body Schrödinger equation with the correct boundary conditions at the nuclear wall. By assuming nuclear forces which fit the low energy two-body data, and an average binding energy of 8 MeV per nucleon, an expression is derived for the absorption coefficient which is compared with the imaginary part of the FPW potential. At zero energy the absorption coefficient is just in the right range 0·03–0·05. For higher energies it becomes so large that already for 6–8 MeV the absorption is almost complete for medium sized nuclei. This agrees quite satisfactorily with experimental evidence. A.

539.172.4

8257. Alternative interpretations of slow-neutron cross sections. O. KOFOED-HANSEN. *Phys. Rev.*, **99**, *No.* 1, 154–8 (*July* 1, 1955).

The many-level formula of the theory of neutron resonance cross-sections developed by Feshbach, Peaslee and Weisskopf has been applied to the lowest resonances in Ag and Au. It is concluded that the approximations involved in the derivation of the usual Breit–Wigner one-level formula may lead to larger deviations in the determination of the constants in this formula than indicated by the usually applied statistical errors. In particular, in the present work a fit is obtained with a nuclear radius given as $1{\cdot}47A^{\frac{1}{3}} \times 10^{-13}$ cm. A.

539.172.4

8258. Manganese thermal neutron activation cross section. J. DEJUREN AND J. CHIN. *Phys. Rev.*, **99**, *No.* 1, 191 (*July* 1, 1955).

The thermal activation cross-section of manganese has been remeasured and found to be $\sigma_{act} = 13{\cdot}1_9 \pm 0{\cdot}3_0$ barn (standard error). This value, combined with previous values, yields a "best average value" of $13{\cdot}2_7 + 0{\cdot}2$ barn. A.

539.172.4

8259. Total cross sections for high-energy neutrons. V. CULLER AND R. W. WANIEK. *Phys. Rev.*, **99**, *No.* 3, 740–8 (*Aug.* 1, 1955).

The total cross-sections for high-energy neutrons have been determined for 12 elements (H, D, C, O, Al, Si, Cl, Ti, Fe, Cu, Hg and Pb) for several points in the range between 60 and 110 MeV. The good-geometry attenuation experiment was conducted in the neutron beam produced by the bombardment of a beryllium target by the internal proton beam of the Harvard 95-in synchrocyclotron. The angular and energy resolution permitted by the use of scintillation-counter telescope techniques is discussed. Results are analysed by using the optical model of the nucleus. A.

539.172.4

8260. Study of the fission cross-sections of U^{233}, U^{235} and Pu^{239} for slow neutrons. J. M. AUCLAIR, P. HUBERT AND G. VENDRYES. *J. nuclear Energy*, **1**, *No.* 4, 306–10 (*June*, 1955) In French.

The fission cross-sections are compared to the capture cross-section of boron in the energy region about 0·01–2 eV. The resulting curves show resonances situated at $1{\cdot}85 \pm 0{\cdot}15$ eV for U^{233}; $0{\cdot}29 \pm 0{\cdot}01$ eV and $1{\cdot}13 \pm 0{\cdot}03$ eV for U^{235}; $0{\cdot}30 \pm 0{\cdot}005$ eV for Pu^{239}. A.

539.172.4

8261. Comparison of the fission cross-sections for thermal neutrons of U^{233} and Pu^{239}. J. M. AUCLAIR, C. BRETON, P. HUBERT, R. JOLY AND J. TACHON. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 24, 2306–8 (*June* 13, 1955) In French.

Thin films of the two nuclides were compared by α-counting and by fission counting in a thermal neutron flux. The ratio of the fission cross-section of U^{233} to that of Pu^{239} was found to be $0{\cdot}626 \pm 1\%$. The neutrons had the usual Maxwellian velocity spectrum. J. M. CASSELS

539.172.4

8262. Fission of U^{235} by 14-MeV neutrons: nuclear charge distribution and yield fine structure. A. C. WAHL. *Phys. Rev.*, **99**, *No.* 3, 730–9 (*Aug.* 1, 1955).

The following results were derived from experiments in which iodine was quickly separated from irradiated uranium metal at a known time after irradiation. The fractional chain yields are based on the cumulative chain yields at iodine.

	Ratio of cumulative yields, 14 MeV/thermal neutron fission	Fractional chain yield 14 MeV	Thermal
I^{131}	$1{\cdot}48 \pm 0{\cdot}07$	$<0{\cdot}08$	$<0{\cdot}01$
Te^{131m}	$5{\cdot}5 \pm 1{\cdot}5$	$0{\cdot}35 \pm 0{\cdot}05$	$<0{\cdot}05$
Te^{131}	—	$<0{\cdot}30$	$<0{\cdot}03$
I^{132}	$1{\cdot}12 \pm 0{\cdot}02$	$0{\cdot}16 \pm 0{\cdot}01$	$<0{\cdot}01$
Te^{132}	$0{\cdot}97 \pm 0{\cdot}02$	—	—
I^{133}	$0{\cdot}81 \pm 0{\cdot}03$	$<0{\cdot}40$	$<0{\cdot}05$
Te^{133m}	$0{\cdot}64 \pm 0{\cdot}15$	—	—
Te^{133}	—	$<0{\cdot}40$	$<0{\cdot}1$
I^{134}	$0{\cdot}65 \pm 0{\cdot}02$	$0{\cdot}43 \pm 0{\cdot}02$	$0{\cdot}11 \pm 0{\cdot}02$
I^{135}	$0{\cdot}69 \pm 0{\cdot}02$	—	—

The error given is the standard deviation of the average of the experimental results; it does not include the 4% standard deviation for the ratio of 14 MeV to thermal neutron fission yields of Mo^{99} used in the calculation of the ratio of cumulative yields. The results indicate that the pronounced peak in the mass-yield curve found at mass number 134 in thermal-neutron fission is nearly washed out in 14 MeV neutron fission. The higher independent yields of late members of the chains in 14 MeV neutron fission indicate a shift toward stability of the most probable initial nuclear charge. This shift is about 0·7 charge units for the chains in the mass region studied. As by-products of the work, the following half-life values were determined: I^{133}, $20{\cdot}9 \pm 0{\cdot}3$ hour; I^{132}, $2{\cdot}30 \pm 0{\cdot}05$ hour; fission precursor of I^{135}, $<0{\cdot}4$ minute. A.

539.172.4 : 536.6

A calorimetric determination of the energy of the fragments from U^{235} fission. *See Abstr.* 7919

539.172.4

8263. An improved d-c amplifier for reactor control. E. J. WADE AND R. S. STONE. *Nucleonics*, **13**, *No.* 4, 28–30 (*April*, 1955).

A direct-coupled amplifier with high open loop gain employs negative feedback to degenerate the input resistance by a large factor, thereby achieving a short response time. The error voltage in the d-c amplifier is amplified in a vibrating capacity amplifier feeding into the differentially connected input stage of the former. This arrangement provides a zero drift input stage. L. R. SHEPHERD

539.172.4

8264. Calculating thermal utilization for large thermal reactors. R. W. HOUSTON. *Nucleonics*, **13**, *No.* 4, 70, 72–4 (*April*, 1955).

Weinberg's equations for calculating thermal utilization factors in an infinite heterogeneous system are extended to include the effect of neutron absorption in the coolant. Results are given for natural U/graphite lattices, with Na coolant, in the cases of externally cooled fuel rods and plates and internally plus externally cooled tubes. L. R. SHEPHERD

539.172.4

8265. ORNL's design for a power reactor package. R. S. LIVINGSTON AND A. L. BOCH. *Nucleonics*, **13**, *No.* 5, 24–7, 46 (*May*, 1955).

A reactor suitable as a small power source at a remote site, is described. The system is cooled and moderated by light water pressurized to 1 200 lb/in^2 with an outlet temperature of 450°F. Steam is produced at 200 lb/in^2 and 382°F at full load. The fuel is highly enriched U clad in stainless steel, less than 25 kg providing 15 MW-yr before reloading. The pressure vessel is made of boiler-plate steel lined with $\frac{1}{8}$ in stainless steel to resist corrosion by the hot water. Reactor power output is controlled on the water outlet temperature with an over-riding control by neutron flux if the power exceeds a certain level. L. R. SHEPHERD

539.172.4

8266. Radiolytic-gas bubbling improves heat transfer in SUPO. F. P. DURHAM. *Nucleonics*, **13**, *No.* 5, 42–6 (*May*, 1955).

Heat transfer from the fissile solution to the walls of the cooling tubes in the SUPO water-boiler reactor is found to be substantially greater than that calculated on classical theory of free-convection heat

transfer, at the higher operating powers. It is shown that the increase can be attributed to agitation of the solution by the evolution of hydrogen and oxygen bubbles in radiation-induced dissociation. Nuclear heat generation in the boundary layer accounts for only a small increase in heat transfer. The bubbles, clinging to the cooling tubes, reduce heat transfer at low powers. L. R. SHEPHERD

539.172.4

8267. Nomographic determination of the thermal utilization factor. M. M. NOVAKOVIĆ. *Bull. Inst. Nuclear Sci.* "*Boris Kidrich*," **4**, 89–95 (*June*, 1954).

A nomogram is given for calculating thermal utilization in uranium–heavy water lattices with air coolant for various lattice cell, channel and uranium rod dimensions. The effect of aluminium canning is derived and incorporated in a second nomogram.

L. R. SHEPHERD

539.172.4

8268. Site selection and plant layout. S. M. STOLLER. *Nucleonics*, **13**, *No.* 6, 42–5 (*June*, 1955).

Factors governing the choice of sites for nuclear power reactors are considered. Some features of the layout and the problem of containment of radioactive products in the event of a power runaway are outlined for various types of reactor. L. R. SHEPHERD

539.172.4

8269. Water supplies for reactors. H. W. HUNTLEY AND S. UNTERMYER. *Nucleonics*, **13**, *No.* 6, 46–7 (*June*, 1955).

Purity requirements and treatment of water supplies used as (1) condenser coolant, (2) boiler feed, and (3) primary coolant for nuclear reactors, are outlined.

L. R. SHEPHERD

539.172.4

8270. Control rod mechanisms. J. M. HARRER. *Nucleonics*, **13**, *No.* 6, 48–51 (*June*, 1955).

Requirements for reactor control rods are outlined and some views on their design are given. A few specific control rod designs are described.

L. R. SHEPHERD

539.172.4

8271. How to load solid-fuel reactors. J. A. BOLTON AND P. T. CALABRETTA. *Nucleonics*, **13**, *No.* 6, 52–5 (*June*, 1955).

Methods of refuelling solid-fuel high powered reactors involving the handling of intensely radioactive fuel elements, are outlined. These range from simple manual methods (use of a "boat-hook") in the swimming pool type of reactor to complicated remote handling techniques which must be employed in liquid metal cooled systems where contact between the coolant and the atmosphere is not possible.

L. R. SHEPHERD

539.172.4

8272. How to design reactor shields for lowest costs. J. A. LANE. *Nucleonics*, **13**, *No.* 6, 56–8 (*June*, 1955).

The determination of optimum design of iron-water thermal shield plus concrete biological shield, for minimum cost, is discussed. Standard, barytes and iron aggregate concretes are considered with right-cylindrical cores of varying size. L. R. SHEPHERD

539.172.4

8273. Determining the geometry of thermal shields. N. F. LANSING. *Nucleonics*, **13**, *No.* 6, 58–9 (*June*, 1955).

Considerations affecting the design of steel-water shields, to reduce the intensity of neutron and γ-radiation emitted from a nuclear reactor to a level sufficiently low for further absorption in concrete, without excessive heating in the latter, are discussed.

L. R. SHEPHERD

539.172.4

8274. How to choose and place mixes for high density concrete reactor shields. H. S. DAVIS. *Nucleonics*, **13**, *No.* 6, 60–5 (*June*, 1955).

Data is tabulated for 9 typical aggregates and 17 types of concrete having high densities suitable for γ-ray shielding. Methods of concrete placement and shield construction are discussed. Improvement of water content and addition of boron, in concretes for neutron shielding, are considered briefly.

L. R. SHEPHERD

539.172.4

8275. Reactor vessels. B. A. MONG AND R. M. DOUGLASS. *Nucleonics*, **13**, *No.* 6, 66–9 (*June*, 1955).

Factors affecting the choice of materials for pressure vessels and containers of nuclear reactors are outlined. These factors include corrosion, radiation damage and thermal stresses arising from radiation heating.

L. R. SHEPHERD

539.172.4

8276. Construction of the SRE core. R. L. OLSON. *Nucleonics*, **13**, *No.* 6, 70–2 (*June*, 1955).

A 20 MW prototype power reactor using slightly enriched uranium fuel rods, graphite moderator and sodium coolant is described. The graphite is divided into 86 hexagonal-section vertical stringers, each canned in zirconium, to prevent leakage of Na into the graphite. The fuel rods are suspended in Zr lined channels running through the graphite stringers. The assembly is contained in an 11 ft dia. stainless steel can. 1 200 gal/min of Na flows upward through the fuel channels attaining a mean outlet temperature of 960°F. The fabrication of the Zr cans is described.

L. R. SHEPHERD

ATOM AND MOLECULAR BEAMS . MESONS NEUTRONS 539.18

539.18 : 530.145

8277. High-energy nuclear physics. B. T. FELD. *Nucleonics*, **13**, *No.* 5, 34–7 (*May*, 1955).

A short discussion on certain aspects of high-energy particle physics including the structure of the proton and μ-meson, the production and stability of heavy mesons and hyperons and recent information on pion-nucleon interaction from mesic X-rays and low-energy scattering experiments. L. R. SHEPHERD

539.18

8278. Report of the Committee on τ-mesons. E. AMALDI, E. FABRI, T. F. HOANG, W. O. LOCK, L. SCARSI, B. TOUSCHEK AND B. VITALE. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 419–32 (1954).

Collects all the data on 40 decays of τ-mesons

giving 3 charged mesons and on 7 decays giving a single charged π-meson of momentum less than 125 MeV/c. Values are given for the Q of the decay, the frequency of production and the branching ratio. The evidence on spin, parity, mean lifetime and charge distribution is reviewed. P. ROTHWELL

539.18

8279. Report of the Committee on jets. U. HABER-SCHAIM, T. F. HOANG, L. SCARSI AND M. TEUCHER. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 472–3 (1954).

Summarizes the evidence presented on the production of heavy mesons in jets, on the interaction cross-section of the secondary particles and on the interpretation of the very large showers. Recommendations are made concerning additional data that should accompany published measurements on jets. P. ROTHWELL

539.18

8280. Heavy unstable particles in nuclear emulsions. M. BALDO, G. BELLIBONI, M. CECCARELLI, M. GRILLI, B. SECHI, B. VITALE AND G. T. ZORN. *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1180–211 (*June*, 1955) In Italian, with summary in English (1½ pp.).

Gives results of a systematic analysis on heavy particles found in nuclear emulsions exposed at balloon altitudes in Sardinia in 1953. A short description of the experimental methods used is given and the data collected on heavy mesons, hyperons, and unstable nuclear fragments is discussed. P. ROTHWELL

539.18

8281. Evidence for the K_{μ}-meson. J. K. BØGGILD, J. E. HOOPER, W. C. G. ORTEL AND M. SCHARFF. Letter in *Nuovo Cimento* (*Ser.* 10) **1**, *No.* 6, 1267–8 (*June*, 1955).

Of 18 K-mesons found in half a stack of stripped emulsions exposed at balloon altitudes five are consistent with the decay scheme $K \rightarrow \mu + \nu$ and lead to a mass value for the primary of $(1\,004 \pm 20)\,m_e$. H. ELLIOT

539.18

8282. On the question of the decay of slow negative π-mesons. V. I. GOL'DANSKIĬ AND M. I. PODGORETSKIĬ. Letter in *Zh. éksper. teor. Fiz.*, **28**, *No.* 5, 620 (1955) In Russian.

Experiments [Abstr. 6910 (1954)] seem to give too many π^--mesons decaying into μ-mesons in emulsions if the lifetimes for decay and capture are analysed. The spread in energy in the μ's indicates that the π's are captured into Coulomb orbits by only light atoms before decaying. G. E. BROWN

539.18

8283. Energy distribution of γ rays from π^0 decay. R. M. STERNHEIMER. *Phys. Rev.*, **99**, *No.* 1, 277–81 (*July* 1, 1955).

It is shown that the γ-ray energy distribution resulting from the decay of π^0-mesons produced in a target bombarded by a high-energy particle beam is related in a simple manner to the differential π^0-production cross-section, for sufficiently high energies of the γ's ($\gtrsim 500$ MeV). An expression is obtained for the π^0-production cross-section in terms of the γ-ray energy distribution. This result is extended to the case of an arbitrary two-body decay, for which an expression is obtained for the production cross-section of the primaries in terms of the energy distribution of the secondaries emitted in the decay. A.

539.18

8284. Associated photons in K-particle decays observed with a multiplate cloud chamber. H. COURANT. *Phys. Rev.*, **99**, *No.* 1, 282–7 (*July* 1, 1955).

The existence of photons among the decay products of K-mesons is confirmed. If these photons arise through a two-body decay process, it is not possible to assume that they are produced directly as the neutral product; however, they can be accounted for quite naturally by assuming that the neutral product is a π^0-meson. The frequency with which the photons are observed is low and for this reason it is not possible to interpret all the decay events observed in the cloud chamber in terms of a single two-body decay process in which the neutral particle is a π^0-meson. The statistical arguments leading to this conclusion are given. A.

539.18

8285. Čerenkov and isotropic radiations from single μ-mesons in air. F. R. BARCLAY AND J. V. JELLEY. *Nuovo Cimento* (*Ser.* 10) **2**, *No.* 1, 27–37 (*July*, 1955).

The Cherenkov effect was used to detect single μ-mesons in 6 m of air at atmospheric pressure. The yield of light and rate of occurrence of events is consistent with the classical theory of the effect. A separate experiment revealed that, in the absence of Cherenkov radiation, the production of light associated with ionization is $<10^{-2}$ of that of Cherenkov radiation, or $<4\times10^{-6}$ of the rate of loss of energy by ionization for relativistic μ-mesons. A.

539.18 : 778.34

8286. A thorough investigation of the accuracy of photoelectric mass determinations. K. KRISTIANSSON. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 394–7 (1954).

The mass distribution for a number of protons with track lengths $>3\,000\mu$ appears Gaussian and gives a standard deviation of 11%. Using calibration protons, 19 μ-mesons give a mean mass of $213 \pm 6\,m_e$. The various components contributing to the final error in a mass determination are discussed and a relationship between range and total error computed. P. ROTHWELL

539.18 : 778.34

8287. The methods of mass measurement by scattering, gap counts and grain counts used by the École Polytechnique group (Paris). A. ORKIN-LECOURTOIS, G. KAYAS AND T. F. HOANG. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 398–404 (1954) In French.

539.18 : 778.34

8288. Mass measurements in photographic plates from photometric ionization measurements. C. MABBOUX AND D. MORELLET. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 405–9 (1954) In French.

Gives a brief description of an apparatus which displays the output of the photomultiplier on an oscilloscope, and the method of reducing the measurements. A check of the method has been made using 35 proton tracks in stripped emulsions with ranges between 7 500 and 10 000 μ. There are some considerations of the accuracy obtainable on the track

of a particle with mass $\sim 1\,000\,m_e$; it is estimated that for a length of $5\,000\,\mu$ a standard deviation of only 7% should be attainable. P. ROTHWELL

539.18

8289. On the mass estimation of charged particles in nuclear photographic emulsions by means of the variable-cell method. B. ROEDERER. *Nuovo Cimento* (*Ser.* 10), **2**, *No.* 1, 135–48 (*July*, 1955) In German.

The method of constant sagitta using the cell-size tables calculated by Fay, Gottstein and Hain [Abstr. 10767 (1954)] was applied for scattering measurements on 10 identified flat protons and 12 π-mesons in the region of short ranges (0–5 000 μm). Applying usual noise elimination methods, a systematic deviation from the theoretically expected values of D_0 was observed in the case of protons. Diverse sources for noise or systematic errors were investigated. Distortion was found to be insignificant. The falsifications of the results yielded by: (i) the error in reading the cell length, (ii) the wrong alignment of the track parallel to the stage movement, although significant, are not sufficient to explain fully the systematic deviation. It is found, however, that the usual way of working out second differences for the double cell size from those measured in the basic cells is not unrestrictedly applicable for the constant sagitta method because adjoining cells are frequently not of equal size. It is suggested that noise elimination on short tracks (up to ~5 mm) should either be done between two different cell schemes, i.e. by measuring each particle twice, e.g. once in the $\pi_{0.5}$ scheme and once in the $p_{0.5}$ scheme; or by applying appropriate corrections in the conventional noise-elimination method. The magnitude of these corrections will then depend on the alignment and length of the track, the mass of the particle and the scheme used. By measuring each particle in two different schemes, one obtains a very good accordance with the values expected by the formula $D_0 = 0{\cdot}5\,(M_{\text{scheme}}/M_{\text{particle}})^{0{\cdot}43}$ without any correction to the scattering constant assumed by Fay *et al.* The calculated noise-level is shown to increase rapidly for double and quadruple cell-size. A.

539.18 : 778.34

8290. Calibration of the constant sagitta method. M. DI CORATO, D. HIRSCHBERG AND B. LOCATELLI. *Nuovo Cimento Suppl.*, **12**, *No.* 2, 381–4 (1954).

The constant sagitta method has been used to measure 46 π-meson tracks and 19 proton tracks at the ends of their ranges. The mean lengths of the tracks used were 12 000 μ for the protons and 4 900 μ for the π-mesons. P. ROTHWELL

539.18

8291. Photoproduction of positive pions in hydrogen—magnetic spectrometer method. R. L. WALKER, J. G. TEASDALE, V. Z. PETERSON AND J. I. VETTE. *Phys. Rev.*, **99**, *No.* 1, 210–19 (*July* 1, 1955).

Positive pions produced in a cold, high-pressure hydrogen gas target by the 500 MeV bremsstrahlung of a synchrotron, have been analysed by a large magnetic spectrometer. The photoproduction cross-section has been measured as a function of photon energy at laboratory angles of 12·5, 30, 51, 73, 104, 140 and 180°. The energy region covered depends somewhat on the angle, but is typically from 200 to 470 MeV. From these excitation curves the angular distribution of the photopions in the centre of momentum system is obtained for various photon energies, and these angular distributions are analysed in the form $A + B\cos\theta + C\cos^2\theta$. The angular distribution has a backward maximum at low energies and a forward maximum at high energies, the coefficient B changing sign at about 340 MeV. The total cross-section shows a striking maximum near 290 MeV, of magnitude 205×10^{-30} cm^2, and falls off above the maximum faster than λ^2. A.

539.18

8292. Photoproduction of positive pions in hydrogen—counter telescope method. A. V. TOLLESTRUP, J. C. KECK AND R. M. WORLOCK. *Phys. Rev.*, **99**, *No.* 1, 220–8 (*July* 1, 1955).

The excitation functions for positive pion production from hydrogen have been obtained in the energy region from 230 MeV to 450 MeV and at laboratory pion angles of 24, 38, 53, 73, 93, 115, 140 and 160°. The pions are detected and identified by measuring their range and ionization in a scintillation counter telescope. The above data are analysed to give the angular distributions in the centre-of-momentum system, and a least squares analysis made to determine coefficients in $\sigma(\theta) = A + B\cos\theta + C\cos^2\theta$. The total cross-section shows a peak at 300 MeV of magnitude $2{\cdot}20 \times 10^{-28}$ cm^2. The coefficient B passes through a maximum negative value at 250 MeV and then passes through zero at 325 MeV and remains positive up to the highest energy measured. A.

539.18

8293. Heavy mesons produced by 2·2- and 3·0-BeV protons. R. D. HILL, E. O. SALANT AND M. WIDGOFF. *Phys. Rev.*, **99**, *No.* 1, 229–41 (*July* 1, 1955).

Emulsions were traversed by radiations from a target bombarded by either 2·2 BeV or 3·0 BeV protons. Analyses of tracks of twelve heavy mesons that came to rest in the emulsions are presented. The stopped heavy mesons produced secondaries showing that 2 were τ-mesons, 1 was a negative K meson, and 9 were positive K mesons. Grain count, scattering and range measurements served to determine K-meson masses; the average of 6 positive K mesons that could be measured well was $(965 \pm 15)m_e$. Evidence is given, from comparison with existing $p\beta$-blob density curves, that one K^+ secondary is a muon or electron, while another K^+ secondary is a pion. If, in the latter case it is assumed that the K^+ decays into a charged and a neutral pion, the mass of the K^+ is found to be $(945 \pm 20)m_e$ and the Q of the decay (207 ± 9) MeV, the same, within experimental error, as for θ^0. A.

539.18

8294. Photoproduction of mesons in deuterium. J. CHAPPELEAR. *Phys. Rev.*, **99**, *No.* 1, 254–60 (*July* 1, 1955).

The corrections from multiple scattering of the photoproduced meson to the usual impulse approximation to the elastic photoproduction cross-section for neutral mesons in deuterium have been computed. The result obtained for γ-ray energies of 285 MeV and 345 MeV is a depression of the cross-section of about a factor of two at all angles and at both energies. This is in qualitative accord with experiment. A.

539.18

8295. Production of heavy unstable particles in a p–p collision. M. M. Block, E. M. Harth, W. B. Fowler, R. P. Shutt, A. M. Thorndike and W. L. Whittemore. *Phys. Rev.*, **99**, *No.* 1, 261–3 (*July* 1, 1955).

A hydrogen-filled diffusion cloud chamber was exposed to a 2·7 BeV proton beam. In a collection of 202 p–p collisions, there was one event interpreted as the associated production of a hyperon and a K-meson, via the reaction $p + p \rightarrow \Lambda^+ + K^+ + n$. A.

539.181

8296. Collision alignment of molecules, atoms, and nuclei. N. F. Ramsey. Letter in *Phys. Rev.*, **98**, *No.* 6, 1853–4 (*June* 15, 1955).

Points out that a beam of molecules, atoms or nuclei with spins $\geqslant 1$ may be aligned by selective transmission through an absorber. J. M. CASSELS

539.185

8297. The slowing down and diffusion of neutrons in finite media [according to elementary diffusion theory]. L. Trlifaj. *Czech. J. Phys.*, **5**, *No.* 2, 121–32 (*April*, 1955) In Russian with summary in English (1 p.).

Elementary diffusion theory and age theory are used. The diffusion problem is first solved for a finite medium containing a source of fast neutrons; the space co-ordinates and the age are separable, and the appropriate eigenfunctions are found. The case of a spherically symmetric finite system of two media, with a fast source at the centre, is then considered, and the solution is obtained by a similar method. It is assumed that the inner medium is a good moderator, and that the corresponding constants for the two media depend in the same manner on the energy. The conditions are also examined under which the fast source at the centre behaves almost as a source of thermal neutrons so far as the second medium is concerned. It is shown that this is so, for a system consisting of a paraffin core in a graphite shell, if the core radius is more then three slowing-down lengths. J. B. SYKES

539.185

8298. Slowing down of neutrons by hydrogenous moderators. H. Hurwitz, Jr and P. F. Zweifel. *J. appl. Phys.*, **26**, *No.* 8, 923–32 (*Aug.*, 1955).

Methods of treating the Boltzmann equation for the case of a sinusoidally distributed source of fast neutrons in a material containing hydrogen are discussed and compared. The effects of the simplifying assumptions commonly employed in reactor calculations are analysed. A technique which is particularly suitable for accurate numerical integration of the Boltzmann equation in the above case is described. Numerical results are being obtained by this method, and will be presented and compared with results obtained from other approximate methods in a subsequent paper. A.

539.185 : 531.719.3

Using neutrons for remote liquid-level gauging. *See Abstr.* 7721

539.185 : 539.152.1

8299. Scattering of polarized neutrons by heavy nuclei. A. Okazaki. *Phys. Rev.*, **99**, *No.* 1, 55–8 (*July* 1, 1955).

The polarization of Li (p, n) neutrons emitted at a laboratory angle of 50° was measured as a function of proton energy from 2·21 to 2·40 MeV. Analysis of the polarization of the neutrons was performed by measuring the left-right asymmetry in scattering by oxygen. To determine more accurately the polarization produced in scattering by oxygen, the total cross-section and angular distribution of scattered neutrons were remeasured. Measurements of the polarization of neutrons produced in the scattering by intermediate and heavy nuclei have been continued. The results were compared with polarizations calculated by assuming the complex square-well model proposed by Feshbach, Porter and Weisskopf and modified by the addition of a spin-orbit interaction. A.

539.185.08

8300. (n, γ) detector for study of low energy neutron resonances with a velocity selector. R. D. Albert and E. R. Gaerttner. *Rev. sci. Instrum.*, **26**, *No.* 6, 572–8 (*June*, 1955).

Development of a neutron capture γ-ray detector for study of neutron resonances by the time-of-flight method is described. The GE 100 MeV betatron is used as a pulsed source of neutrons. Gamma-rays are detected by a pair of large annular counters, each containing toluene–terphenyl scintillation phosphor and four 5819 photomultipliers. The counters have a 4 in dia. opening for the neutron beam, which passes first through one, then the sample radiator, then the other; all centred on a common axis. Each counter subtends about 40% of the total solid angle, and has a detection efficiency of about 5% for 1 MeV γ-radiation. The two detectors are connected in coincidence, with a resolving time of about 10^{-8} sec. Use of the instrument for measuring capture level densities is illustrated by a resonance curve for gold. The detector is also used for measurement of neutron transmission with thick samarium oxide as the radiator. This application is illustrated by transmission curves for manganese. A.

539.185.08 : 778.34

8301. A slide rule technique for calculating neutron energies from tracks in nuclear emulsions. J. P. Scanlon. *J. sci. Instrum.*, **32**, *No.* 8, 308–9 (*Aug.*, 1955).

The calculation of neutron energies from the ranges of proton recoils is reduced to a form suitable for use with a slide rule. The modifications required for a standard slide rule and the method of operation are described. The technique can be used for all neutron energies greater than 1 MeV. A.

539.185.9 : 539.32

Effect of atomic-pile radiation on the elastic modulus of an austenitic steel. *See Abstr.* 8321

STRUCTURE OF SOLIDS 539.2

539.211

8302. Condition of high-velocity ductile fracture. E. Orowan. *J. appl. Phys.*, **26**, *No.* 7, 900–2 (*July*, 1955).

The Griffith energy criterion, $dW = -dU$ (dW = crack propagation work, $-dU$ = released elastic

energy), cannot be applied to essentially ductile fractures. In particular, it does not represent the condition of rapid ductile fracture propelled by the elastic energy of the specimen. The condition of such fractures is $d^2W/dx^2 = -d^2U/dx^2$, where x is the plastic extension accompanying the propagation of the crack. A.

539.213

8303. The structure of amorphous selenium. H. GRIMMINGER, H. GRÜNINGER AND H. RICHTER. Note in *Naturwissenschaften*, **42**, *No.* 9, 256 (1955) In German.

The atomic distribution at liquid air temperature agrees with a parcel or layer structure of Se_6 molecules, at room temperature with a half-and-half mixture of crystalline particles and amorphous parcel structure. C. TURNER

539.217

8304. On the activation energy of the phenomenon of diffusion of nitrogen in α-Fe. I. BARDUCCI. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 122–3 (1955) In Italian.

Measurements of the internal friction of solid solutions of N in α-Fe over a wide frequency range allow determination of the activation energy over the range $T = -30$ to 200°C. The measurements entirely confirm earlier results over a more limited range, and give $H = 18\,200$ cal/mole. and $D_0 = 3 \times 10^{-3}$ cm²/sec. W. M. LOMER

539.217

8305. On the question of the diffusion of carbon in iron. L. ŠPAČEK. Letter in *Czech. J. Phys.*, **5**, *No.* 2, 273–5 (*April*, 1955) In Russian.

539.217

8306. Diffusion of zinc in crystalline zinc oxide. E. A. SECCO AND W. J. MOORE. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1170 (*June*, 1955).

Experimental results on the diffusion-controlled exchange of radioactive Zn^{65} from crystals of ZnO with Zn vapour give $D = 4{\cdot}8 \exp(-73\,000/RT)$ at Zn pressure of 1 atm. The variation of D as function of pressure followed $D \propto p^{0{\cdot}65}$ suggesting diffusion by single Zn^+ ions. W. M. LOMER

539.217

8307. Self-diffusion in α white phosphorus. N. H. NACHTRIEB AND G. S. HANDLER. *J. chem. Phys.*, **23**, *No.* 7, 1183–93 (*July*, 1955).

The coefficient of self-diffusion in α-white phosphorus from 0° to the melting point is given by the equation

$$D = 1{\cdot}07 \times 10^{-3} \exp(-9\,400/RT) + 2 \times 10^{46} \exp(-80\,600/RT) \text{cm}^2\text{sec}^{-1}.$$

Only the first term is important for temperatures below 30°, where the vacancy mechanism is believed to operate. The activation energy in this range is in excellent agreement with the value predicted from the latent heat of fusion. A second mechanism begins to become important above 30°, with an activation energy of 80 600 cal. and an exceedingly large entropy. This process is interpreted as a comparatively large-scale disorder which arises on multiple vacancies. The entropy and energy are consistent with the view that liquid microphase regions containing, on the average, about 130 molecules and 10 distributed vacancies are the principal centres of diffusion near the melting point. A.

539.217

8308. Effect of pressure on self-diffusion in white phosphorus. N. H. NACHTRIEB AND A. W. LAWSON. *J. chem. Phys.*, **23**, *No.* 7, 1193–5 (*July*, 1955).

Pressure decreases the rate of self-diffusion in α-white phosphorus. At 30°C the activation volume is 30 cm³, a value which indicates that considerable lattice relaxation takes place about vacancies. At 41·30°C the activation volume is about an order of magnitude larger, a behaviour consistent with a view that lattice disordering on a comparatively large scale begins well below the melting point. A.

539.217

8309. Tracer diffusion of iron in stainless steel. V. LINNENBOM, M. TETENBAUM AND C. CHEEK. *J. appl. Phys.*, **26**, *No.* 8, 932–7 (*Aug.*, 1955).

The tracer diffusion of iron in 18–8 stainless steel has been measured over a wide temperature range by the surface activity decrease method, using radioactive Fe^{55}. The results show that the lattice diffusion coefficients can be described by the equation $D = 0{\cdot}58 \exp(-67\,100/RT)\text{cm}^2\text{sec}^{-1}$. The effect of variations in grain size has been determined, and it has been shown that when the grain size is small, grain boundary diffusion contributes appreciably to the over-all diffusion process, this effect decreasing with increasing temperature. A.

539.219

8310. Study of the kinetics of ordering in the alloy AuCu. G. C. KUCZYNSKI, R. F. HOCHMAN AND M. DOYAMA. *J. appl. Phys.*, **26**, *No.* 7, 871–8 (*July*, 1955).

Ordering in the alloy AuCu was studied by measurements of the electrical resistivity as a function of time and temperature of ordering for samples disordered at various temperatures above the critical point. It has been established experimentally that the disordering temperature has a profound affect upon the rate of ordering. The higher the disordering temperature the faster is the rate of subsequent ordering. The dependence of the rate of ordering on the ordering temperature seems to indicate that the transformation is nucleated even at very low temperatures. The appearance of a twin-like structure during the disorder-to-order transformation has also been studied as a function of the previously mentioned variables. A.

539.234 : 538.221 : 621.318.1

8311. Preparation of thin magnetic films and their properties. M. S. BLOIS, JR. *J. appl. Phys.*, **26**, *No.* 8, 975–81 (*Aug.*, 1955).

Techniques for the preparation by vacuum evaporation of single thin layers and laminated structures of ferromagnetic alloys (principally in the iron–nickel system) are described. The magnetic properties are related to those parameters of the process which may be chosen to yield materials having desired characteristics. A method for producing films with extreme hysteresis loop rectangularity is described. Questions of suitable substrate materials, evaporable dielectrics

for use in insulating multilayer deposits, and control of alloy composition, are considered in detail. A.

539.26

8312. Submicroscopic structure determination by long wavelength X-ray diffraction. B. L. HENKE AND J. W. M. DUMOND. *J. appl. Phys.*, **26**, *No.* 7, 903–17 (*July*, 1955).

Reviews the theory of low angle X-ray diffraction as applied in the long wavelength region for the determination of particle sizes and shapes and other structural features in the submicroscopic size range and emphasizes the advantages to be gained by employing the longer X-ray wavelengths (8 to 25 Å). It also is intended to serve as an introduction to a description of an entirely new instrumental technique developed for this long wavelength range utilizing a diffraction apparatus consisting of a special gas-filled X-ray tube and a total reflection camera in which the primary radiation is simultaneously monochromatized and made to converge to a point focus. The sample for study is placed in the converging part of the primary beam and the diffraction patterns are formed around the point focus on a photographic film. A.

539.26 : 537.583

8313. An X-ray study of barium–strontium–calcium triple oxide. J. TERADA. *J. Phys. Soc. Japan*, **10**, *No.* 7, 555–65 (*July*, 1955).

Triple oxide coatings were studied by means of X-ray powder patterns using a protective film coating technique. Uniform solid solution of the three constituents was not found. Three phases of oxide solid solution were usually found with the heat treatment at a temperature where the preferential evaporation loss of the BaO component does not yet take place. When treated with the temperature above 1 000°c, the evaporation loss of BaO became appreciable, causing a remarkable deformation of the shape, and also broadening, of the X-ray diffraction lines. In some cases this line broadening is explained by so-called microstress theory. A possible explanation for the reason of the good emission of the triple oxide cathode is given. A.

539.27

8314. Identification of materials by electron diffraction in the electron microscope. H. I. MATTHEWS AND H. WILMAN. *Brit. J. appl. Phys.*, **6**, *No.* 8, 277–80 (*Aug.*, 1955).

The recognition and avoidance of impurities are briefly discussed. It is shown that in the use of electron microscopes for the electron diffraction identification of specimen nature, the minute particles worn off the brass specimen holder during the mounting of the specimen sometimes give rise to deposits of zinc, zinc oxide and lead. Specimen holders should therefore be of a material harder and less volatile than brass. It is emphasized that in order to use diffraction intensities reliably for identification, or to assist in determination of lattice form and dimensions, patterns should be obtained with the specimen film inclined to the electron beam. In the identification of electron diffraction patterns valid use can be made of X-ray powder-pattern data, although the relative ring intensities differ appreciably from those in electron diffraction. A.

ELASTICITY . STRENGTH . RHEOLOGY
539.3/.8

539.31 : 548.1 : 550.3

8315. On the symmetries of physical properties. Application to mechanics, crystallography and geophysics. M. MATSCHINSKI. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 22, 2117–20 (*June* 1, 1955) In French.

In particular considers in the most general case the symmetries of the tensors of the 4th order for linear elasticity. The systems are tabulated and their applications are indicated. S. WEINTROUB

539.32

8316. Vibroscope measurements of the elastic moduli of Nylon 66 and Dacron filaments of various draw ratios. J. H. WAKELIN, E. T. L. VOONG, D. J. MONTGOMERY AND J. H. DUSENBURY. *J. appl. Phys.*, **26**, *No.* 7, 786–92 (*July*, 1955).

By use of the electrostatic vibroscope method, dynamic measurements have been made of the Young's modulus derived from bending and the torsional modulus of Nylon 66 and Dacron filaments ranging in draw ratio from one (undrawn) to six. Quasistatic measurements have also been made to obtain the Young's modulus derived from extension. The dynamic values of the Young's modulus increase from draw ratio one to draw ratio six by a factor of 3·5 for Nylon 66 and 5·8 for Dacron. The torsional moduli of both filament types exhibit no appreciable changes with increasing draw ratio. The ratio of the Young's modulus to three times the torsional modulus, which ratio is unity for a homogeneous isotropic material with a Poisson's ratio of $\frac{1}{2}$, is about three for Nylon 66 and greater than five for Dacron at a draw ratio of six. These results, along with those obtained at lower draw ratios, indicate that both filaments become progressively anisotropic with drawing, the extent of the anisotropy reflecting mainly the changes in the Young's modulus. As a check on the experimental procedures, the elastic moduli have also been measured for a 1×10^{-3} in. drawn tungsten wire. A.

539.32

8317. A simple method of measuring the dynamic Young's modulus of concrete. J. P. A. LOCHNER AND W. DE V. KEET. *J. sci. Instrum.*, **32**, *No.* 8, 296–9 (*Aug.*, 1955).

The dynamic Young's modulus of elasticity E of solids can conveniently be determined from the fundamental transverse frequency of bars. A very simple device is described consisting of a calibrated adjustable Helmholtz resonator, the resonance of which can be observed by means of a stethoscope, for measuring the natural transverse frequency of a rod struck with a small hammer. A.

539.32 : 534.26

8318. Determination of elastic constants of solids by ultrasonic diffraction methods. G. S. VERMA. Letter in *Nature* [*London*] **176**, 27–8 (*July* 2, 1955).

Debye–Sears equipment for observing ultrasonic diffraction patterns is used for detecting the two critical angles of internal reflection when a thin plate of polycrystalline material is rotated about a vertical axis in the beam of a quartz transducer. These critical angles, shown by the absence of a diffraction

pattern, are the angles at which the longitudinal and shear waves cease to be transmitted. Expressions are given for relating the critical angles and the elastic constants of the plate material and a table gives data for Al, Ag, Ni, Zn, brass, steel and glass.

H. J. H. STARKS

539.32 : 536.421.1

8319. Tangential modulus in some metals near the melting point. P. G. BORDONI AND M. NUOVO. *Nuovo Cimento Suppl.* (*Ser.* 10) **1,** *No.* 2, 155–8 (1955).

The velocity of torsional waves in wires of lead, bismuth and tin is determined as a function of temperature up to within a few degrees of the melting point. It is found that there is only a drop of about 15% between $T/T_m = 0{\cdot}5$ and $T/T_m = 0{\cdot}97$; the value must therefore drop to zero rather sharply as the melting point is approached. W. M. LOMER

539.32 : 536.48

8320. Elastic constants of germanium between 1·7° and 80°K. M. E. FINE. *J. appl. Phys.*, **26,** *No.* 7, 862–3 (*July*, 1955).

The elastic constants of germanium (c_{11}, c_{12} and c_{44}) increase on cooling and approach constant values for very low temperatures. A.

539.32 : 538.221

Magneto-elasticity of polycrystalline iron and nickel. *See Abstr.* 8077

539.32 : 539.185.9

8321. Effect of atomic-pile radiation on the elastic modulus of an austenitic steel. A. CHARLESBY, N. H. HANCOCK AND H. C. SANSOM. *J. nuclear Energy*, **1,** *No.* 4, 264–73 (*June*, 1955).

A sensitive method has been designed for measuring changes in the elastic modulus of a metal during irradiation in an atomic pile. The behaviour of "Elinar," an austenitic alloy, has been studied at 62 and 70°C over a period of up to eight weeks' irradiation in an atomic pile (i.e. for a total integrated flux of 10^{19} neutrons/cm^2). Over a period of three weeks' irradiation there was a decrease of less than 0·1% in the elastic modulus of two specimens, and about 0·3% in a third specimen. Further irradiation to six weeks restored the elastic modulus to its original value. The change in modulus of the various springs tested is not considered to be statistically significant. A.

539.32 : 548.736

The determination of the elastic constants of silicon by diffuse X-ray reflexions. *See Abstr.* 8413

539.375

8322. Note on "An approximate theory of armor penetration." W. T. THOMSON. Letter in *J. appl. Phys.*, **26,** *No.* 7, 919–20 (*July*, 1955).

See Abstr. 2254 (1955).

539.4.016.2

8323. The investigation of cold working texture in iron using the Bitter–Akulov colloid technique. L. ŠPAČEK. Letter in *Czech. J. Phys.*, **5,** *No.* 2, 275–6 (*April*, 1955) In Russian.

539.4.016.2 : 534.22

8324. An electroacoustical study on cold-working and recrystallization of aluminium. F. GATTO. *Nuovo Cimento Suppl.* (*Ser.* 10) **1,** *No.* 2, 124–5 (1955).

Sound velocity in rolled, extended or drawn specimens of Al, both before and after annealing, is orientation-dependent, and increases of 1% have been observed on annealing. This is attributed to preferred orientation effects. W. M. LOMER

539.4.016.3

8325. Residual stresses after case hardening by inductive heating. F. BOLLENRATH AND W. DOMKE. Note in *Naturwissenschaften*, **42,** *No.* 7, 174 (1955) In German.

Measurements of the longitudinal, tangential and radial components of residual stress in cylinders of three different steels show that Sachs's procedure [Sachs, G., *Z. Metallkunde*, **19,** 352 (1927)] may give erroneous values if the elastic limit is exceeded during boring tests. J. H. MASON

539.4.016.3 : 548.7

8326. Quench hardening in aluminium single crystals. R. MADDIN AND A. H. COTTRELL. *Phil. Mag.*, **46,** 735–43 (*July*, 1955).

A large increase in the critical shear stress of high-purity aluminium single crystals can be achieved by water quenching, instead of furnace cooling, after annealing at a high temperature. This quench-hardening effect is insensitive to purity and is present in crystals of zone-refined aluminium. It increases rapidly with increase in the quenching temperature. The fully hardened state is reached, not instantly upon quenching, but only after ageing at room temperature. Various observations suggest that while quenching strains may be partly responsible for the hardening they cannot account for the whole effect, and that quenched-in vacancies also make an important contribution. A.

539.434

8327. Effect of molecular weight distribution on the creep behavior of cellulose acetate. D. L. SWANSON AND J. W. WILLIAMS. *J. appl. Phys.*, **26,** *No.* 7, 810–15 (*July*, 1955).

Creep measurements were carried out at 80°C on cellulose acetate fractions characterized as to molecular weight distribution by the equilibrium ultracentrifuge. Stress levels were low enough that linear viscoelastic behaviour was observed. Although the effect of molecular weight was not marked, the presence of low molecular weight material in a sample decreased the amount of permanent set and increased the recoverable deformation. In all cases, more than half of the recoverable deformation occurred in less than 10sec. The results suggest that there was present some sort of a network, although no direct X-ray evidence for crystallinity could be seen. A.

539.501

8328. A rheological equation of state which predicts non-Newtonian viscosity, normal stresses, and dynamic moduli. T. W. DEWITT. *J. appl. Phys.*, **26,** *No.* 7, 889–94 (*July*, 1955).

An equation of state is formulated from the classical Maxwell assumptions of superposition of the effects due to strain and rate of deformation in a strained fluid. Except for the form of the time derivative, these assumptions result in the usual expression for a Maxwell element. The time derivative of the stress, however, is computed with respect to a set of axes in the fluid which are rotating (with respect to fixed axes) at a rate measured by the vorticity of the assumed

velocity distribution. The usual transformation between rotating and fixed reference axes introduces cross terms between the stress and vorticity components. The resulting equation of state predicts non-Newtonian behaviour and the simultaneous appearance of normal stresses. It reduces to the Newtonian case for low rates of shear (or for small relaxation times) and, if the cross terms are sufficiently small (but not otherwise), to the usual Maxwell element expression in the dynamic case. A common origin is thus assigned to these several phenomena. Reduced variable and distribution function procedures, at least in principle, should be as applicable to the viscosity and pressure phenomena as to dynamic data. A.

539.501 : 532.511

8329. Theory of non-Newtonian flow. I. Solid plastic system. T. Ree and H. Eyring. *J. appl. Phys.*, **26**, *No.* 7, 793–800 (*July*, 1955).

The relaxation process of viscous flow may be visualized as the sudden shifting of some small patch on one side of a shear surface with respect to the neighbouring material on the other side of the shear surface. Any shear surface will divide a mosaic of such patches lying on the two sides of the surface. Except for the simplest systems, this mosaic of patches will be heterogeneous and can be described by groups each characterized by its mean relaxation time β_n, by x_n the fractional area of the shear surface which the group occupies and by α_n, a characteristic shear volume divided by kT. The resulting generalized expression for viscosity is

$$\eta = \sum_{n=1}^{n} \frac{x_n \beta_n}{\alpha_n} \frac{\sinh^{-1} \beta_n \dot{s}}{\beta_n \dot{s}}$$

where $\dot{s}$ is the rate of shear. This equation is applied to masticated natural rubber, polystyrene, X-672 GR-S, X-518 GR-S rubber, and Vistanex LM-S polyisobutylene. All applications give good agreement with experiment. The known criticisms of Eyring's simple relaxation theory for viscous flow are reviewed, and are apparently taken care of in this general treatment. A.

539.501 : 532.511

8330. Theory of non-Newtonian Flow. II. Solution system of high polymers. T. Ree and H. Eyring. *J. appl. Phys.*, **26**, *No.* 7, 800–9 (*July*, 1955).

The theory developed in Pt I is applied to solutions of polystyrene, polyisobutylene, X-518 GR-S rubber, and lime base grease with good agreement with experiment. The parameters, x_n/α_n and β_n were calculated, and are tabulated; these parameters are proportional to the surface concentration and the relaxation time of the nth group of flow units, respectively. The effects of the molecular weights of polymers, concentration, solvent, and temperature on these parameters were studied. The results establish the following facts: (1) The heterogeneity of flow units increases with increasing molecular weight. (2) In the range of low concentration, β_n (relaxation time) is independent of concentration, while the areal concentration of non-Newtonian units increases more rapidly than proportional to the bulk concentration of a polymer. (3) A "good" solvent increases the concentration of non-Newtonian units, while the contrary is true for a "poor" solvent. (4) In poor solvent solutions, the concentration of non-Newtonian units increases with increasing temperature, while the concentration is independent of temperature in good solvents. A.

539.531

8331. Adaptation of Bergsman microhardness tester to American Optical metallograph. E. W. LaRocca. *Rev. sci. Instrum.*, **26**, *No.* 6, 590–1 (*June*, 1955).

The Bergsman microhardness testing machine, used in conjunction with conventional metallurgical microscopes, has been adapted for use with a turret-type metallograph with parfocalized and indexing objectives. Details of adaptors necessary to accommodate the Bergsman unit to the American Optical research metallograph are given, including a description of the method used. The observation and measurement of microhardness values, usually a time-consuming and tedious operation, is greatly simplified since the diamond (Vickers) indentor is mounted in the turret and left in place, eliminating the necessity of replacing the penetrator with the objective lens, as is usually done with single objective metallographs. The load is applied by means of the fine focus adjustment, which raises the indentor rather than lowering the massive stage. Advantages of the combined system are its simplicity, speed and improved accuracy, as well as the reduction in wear of moving parts. A.

539.576 : 539.61

8332. Metal transfer and the wear process. M. Kerridge. *Proc. Phys. Soc. B*, **68**, *Pt* 7, 400–7 (*July*, 1955).

Experiments were made with a radioactive, annealed steel pin rubbing against a hardened steel ring to compare the amount of wear with the amount of metal transferred from one surface to the other by welding. It was found that a layer of transferred matter from the pin was formed on the surface of the ring and that an equilibrium condition was reached in which the loss of wear debris from this layer was balanced by further transfer. By using a combination of radioactive and inactive test-pieces the rate of transfer to the ring in the equilibrium condition could be estimated and was found to be the same as the wear rate of the pin. There was no evidence that any loose wear particles were formed by direct removal of material from the pin. The transferred layer became oxidized due to frictional heating and it is concluded that the wear process consisted of three stages: transfer of metal, oxidation of the transferred layer, and the subsequent removal of the oxide to form a loose wear-product. A.

539.58

8333. Compression of the alkali metals to 10 000 atmospheres at low temperature. C. A. Swenson. *Phys. Rev.*, **99**, *No.* 2, 423–30 (*July* 15, 1955).

A technique originally developed by Bridgman has been used to measure the total compressions of the alkali metals (Li, Na, K, Rb and Cs) for pressures up to 10 000 atm at 4·2 and 77°K. The unusual features found were an abnormally low decrease in compressibility with pressure for caesium, probably connected with a smearing out of the electronic transition found at 45 000 atm at room temperature, and a possible transformation in rubidium at 77°K which resulted in

a permanent increase in the room temperature density of about 10%. A comparison of these data with theoretical work by Bardeen shows better agreement than was obtained with an extrapolation of room temperature data to absolute zero, although the agreement is satisfactory only for sodium. Approximate densities also were obtained at these temperatures, and the agreement with unpublished calculations by Brooks is excellent for all the metals except lithium, where a deviation could be expected to occur. A.

539.621

8334. Surface film formation and lubrication. J. K. LANCASTER. *Research* Correspondence, **8**, *No.* 7, S 33–S 35 (*July*, 1955).

Contact resistances between sliding surfaces have been measured for various lubricants to determine the function of solid insulating films in initiating hydrodynamic lubrication. For lower viscosity lubricants, the magnitude of the contact resistance increased only slightly with sliding speed and is considered to be largely determined by the formation of solid insulating films. With higher viscosity lubricants the resistance increased rapidly with speed and is assumed to be primarily the result of the increasing tendency of the surfaces to be separated by a hydrodynamic fluid film. Although solid surface films are not an essential preliminary to hydrodynamic lubrication, their presence facilitates the formation of a fluid film. They tend to decrease intermetallic contact during sliding, which leads to the generation of a smoother surface finish. J. A. SPINK

PHYSICAL CHEMISTRY 541

PHASE EQUILIBRIUM . CHEMICAL REACTIONS 541.11/.12

541.123

8335. Systematic behaviour of mixed phases. H. MAUSER AND G. KORTÜM. *Z. Naturforsch.*, **10a**, *No.* 4, 317–22 (1955) In German.

It is shown from thermodynamic considerations that supplementary additions to the thermodynamic mixture effect in liquid mixed phases are mutually opposed. Apart from anomalous cases, the additional values are zero for all temperatures and pressures in ideal mixtures, but are finite in real mixtures. Ideal, regular, athermal and constant-volume mixtures are considered. Twelve references. H. H. HODGSON

541.123.2

8336. Thermodynamic considerations on separation in liquid two-component systems. G. REHAGE. *Z. Naturforsch.*, **10a**, *No.* 4, 300–17 (1955) In German.

General equations, based on phase stability criteria, are derived for the critical solution point in a binary mixed phase. The forms of the limiting stability and coexistence curves are discussed, the curvature of the former being three times that of the latter. The necessary conditions are derived for the existence of an upper or lower critical solution point in the T, x- and P, x-diagrams (where x is the mole fraction). The separation behaviour of ideal, athermal, regular and irregular solutions are described. Seven illustrations and 66 references. H. H. HODGSON

541.123.2

8337. Phase diagram of liquid ozone–oxygen system. C. BROWN, A. W. BERGER AND C. K. HERSH. *J. chem. Phys.*, **23**, *No.* 7, 1340–3 (*July*, 1955).

Vapour pressure composition data for liquid ozone–oxygen mixtures were obtained at −195·5, −183 and −180°C. The vapour pressure isotherms were used to construct the boiling point-composition line at one-atm pressure. The vapour pressure of pure liquid ozone defines an upper limit for the partial pressure of ozone in the vapour in equilibrium with boiling liquid. The vapour pressure of ozone–oxygen solutions deviates markedly from Raoult's law in a positive direction. It is suggested that the apparent boiling point maximum reported by Schumacher, which implies negative deviations, may be due to difficulties in analysis of ozone at high concentrations where it is subject to decomposition at ordinary temperatures. Liquid–liquid equilibrium data are reported which indicate −180°C as an upper bound for the consolute temperature. The region of two liquid phases extends from 9 to 91% ozone by weight at −195·5°C, 29·8 to 72·4% at −183°. A.

541.123.2 : 539.155.2

8338. Concentration of nitrogen-15 by chemical exchange in a thermal diffusion column. W. SPINDEL AND T. I. TAYLOR. *J. chem. Phys.*, **23**, *No.* 7, 1318–22 (*July*, 1955).

A concentration of nitrogen-15 has been effected in a thermal diffusion column under conditions where the gaseous exchange action, $N^{14}O_2 + N^{15}O \rightleftarrows N^{15}O_2 + N^{14}O$, can contribute to the separative process. The top of the column is fed with NO_2 of normal isotopic abundance. Reversible thermal decomposition of NO_2 into NO and O_2 establishes a radial concentration gradient so that the descending cold stream is predominantly NO_2 and the inner hot ascending stream is largely NO and O_2. As a result of the exchange reaction, N^{15} preferentially concentrates in the NO_2 and is carried to the bottom of the column. Here the enriched NO_2 re-enters the hot rising stream and is again decomposed into NO which undergoes further exchange. This reversible thermal decomposition makes it possible to operate the column without a chemical convertor as was needed in the CO–CO_2 system. The over-all isotope separation has been studied in a 2 m column as a function of pressure (0·25 to 1·0 atm), temperature (400 to 700°C) and withdrawal rate (5 to 66 cm^3 atm per day). A maximum over-all separation of 2·6 was obtained at a filament temperature of 685°C and a pressure of 0·5 atm. At a withdrawal rate of 27 cm^3 atm the over-all separation is about 70% of this maximum value. The system is a rather complicated one, and it is not yet possible to completely evaluate the contribution of each separative process that can occur in the column. A.

541.124

8339. On the mass spectrometric study of chemical reactions initiated by gas discharges. J. BEAUSSIER. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2071–3 (*May* 23, 1955) In French.

Two types of r.f. glow discharge in air—capacitive and inductive—were studied, and NO/N_2 ratio measured at fixed r.f. power as a function of pressure at different frequencies. R.F. power was in range 0·5–2 kW at frequencies of 5–25 Mc/s. Using capacitive discharge, a maximum in NO/N_2 ratio was observed at a few mm's of Hg; with inductive type. NO formation was almost independent of pressure in region 0·5–10 mm Hg. N. M. KING

541.124 : 539.132

8340. Intramolecular energy transfer in bimolecular reactions. H. O. PRITCHARD. *Recueil Trav. chim. Pays-Bas*, **74**, *No.* 6, 779–87 (*June*, 1955).

The possible contribution of internal degrees of freedom to the activation of simple bimolecular reactions is discussed in terms of a classical model; it is suggested that existing experimental data on the reactions of halogen atoms with isobutane and of sodium atoms with the alkyl halides may prove to be examples of such behaviour. A.

541.126

8341. Measurement of the Chapman–Jouguet pressure and reaction zone length in a detonating high explosive. R. E. DUFF AND E. HOUSTON. *J. chem. Phys.*, **23**, *No.* 7, 1268–73 (*July*, 1955).

The Chapman–Jouguet pressure and the reaction zone length in detonating Composition B containing 63% RDX at a density of 1·67 g/cm³ have been measured by determining the initial free surface velocity imparted to aluminum plates as a function of plate thickness. The *C–J* pressure is 0·272 megabar and the reaction zone length is 0·13 mm. The experimental free surface velocity-plate thickness curve provides powerful confirmation for the pressure profile in a detonating explosive predicted by the hydrodynamic theory of detonation proposed by Zeldovich, von Neumann and Doring. A.

541.127

8342. Contribution to the theory of fast reaction rates. R. DE VOGELAERE AND M. BOUDART. *J. chem. Phys.*, **23**, *No.* 7, 1236–44 (*July*, 1955).

Classical calculations of the motion of a mass point on a potential surface are carried out. The surface corresponds to a reaction of the type $AB + A = A + BA$ and is characterized by a single saddle-point. With reference to the mathematically similar problem of the allowed cone of cosmic radiation, a novel feature of fast chemical kinetics is described: the possibility of a substantial decrease of the transmission coefficient above a certain critical energy of the system. This result does not depend on the analytical expression of the surface chosen in the present work. The generality and some consequences of this phenomenon are discussed. A.

541.128 : 537.311.32

8343. The electric conductivity and catalytic activity of ZnO–Fe_2O_3 mixtures. A. BIELAŃSKI, J. DEREŃ AND J. HABER. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 4, 223–7 (1955).

Study of conductivity changes in the catalyst during the catalytic oxidation of ethyl alcohol. A correlation is found between the catalytic activity and the change in its conductivity when the reaction substrates are introduced. The non-sintered catalyst gave the largest yield and by far the largest conductivity change. The catalyst sintered at 1 200°C gave only a poor yield and a negligible conductivity change.

C. A. HOGARTH

ELECTROCHEMISTRY 541.13

541.13 : 537.36 : 541.18.045

8344. Magnification of resolution of electrophoretic sorting patterns. A. KOLIN. Note in *Naturwissenschaften*, **42**, *No.* 12, 367–8 (1955).

See Abstr. 588, 4148 (1955). A detailed description of a simple device and its use for increasing the separation and width of the laminae obtained in the electrophoretic sorting of proteins. W. GOOD

541.132

8345. On the specific adsorption of ions in the electrical double layer. D. C. GRAHAME. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1166 (*June*, 1955).

An expression is derived for n^i/n_{0i} in terms of $V(r_0)$ and $(\partial^2 V/\partial r^2)_{r=r_0}$ for ions of type X_i [n^i = excess of ions in the double layer, n_{0i} = conc. of ions in the interior of the solution, $V(r)$ = average potential of an ion at a distance r from the plane interface, r_0 = value of r at the minimum of $V(r)$]. S. J. GREGG

541.133

8346. Conductances of trimethylphenylammonium chloride and iodide in water and in dimethylformamide at 25°C. P. G. SEARS, E. D. WILHOIT AND L. R. DAWSON. *J. chem. Phys.*, **23**, *No.* 7, 1274–6 (*July*, 1955).

The conductances of trimethylphenylammonium chloride and iodide in water and in dimethylformamide have been measured at 25°C. Solute concentrations ranged for 0·6 to 30×10^{-4}N. Limiting equivalent conductances for the salts in both solvents have been evaluated by the Shedlovsky extrapolation method. Trimethylphenylammonium chloride and iodide are more conducting but only slightly more highly dissociated in water than in dimethylformamide. A possible explanation for the reversal of the magnitude of the conductance of the iodide and the chloride ions in very dilute solutions in these two solvents is given. A.

541.135.5

8347. Overvoltages at the electrode: melted $Pb/PbCl_2$. R. PIONTELLI AND G. STERNHEIM. Letter in *J. chem. Phys.*, **23**, *No.* 7, 1358 (*July*, 1955).

By means of a reference electrode of special design a cell assembly (with the $Pb/PbCl_2$ electrode) is achieved in which a uniform current density distribution exists at the electrode surface. It was found that the overvoltages were apparent, being purely ohmic in character. W. GOOD

541.135.5 : 548.5

8348. Oriented overgrowths of iron by electrodeposition. J. A. JAMES. *Trans Faraday Soc.*, **51**, *Pt* 6, 833–5 (*June*, 1955).

Oriented overgrowths of iron have been produced on substrates of copper, gold and nickel–iron alloy by electrodeposition under controlled conditions. The electrodeposits were removed from the substrate and magnetic tests made. It was found that oriented growth is possible to relatively large thicknesses (0·004 in.) even when there exists a large atomic misfit between the deposit and the substrate. A.

PHOTOCHEMISTRY . RADIATION CHEMISTRY 541.14/.15

541.14

8349. Mass spectrometric detection of radicals in the mercury photosensitized decomposition of acetone. J. B. FARMER, F. P. LOSSING, D. G. H. MARSDEN AND E. W. R. STEACIE. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1169 (*June*, 1955).

The large absorption coefficient of mercury vapour for 2537 Å resonance radiation was used for the investigation of this decomposition. Under some conditions the extent of decomposition reached 80%. CH_3 and CH_3CO radicals were found as well as the dimers of these. CO, ketene, CH_4 and H_2 were also formed, but no acetonyl radical. A. J. TAYLOR

541.14

8350. Mercury sensitized decomposition of ethylene. R. J. CVETANOVIĆ AND A. B. CALLEAR. Letter in *J. chem. Phys.*, **23**, *No.* 6, 1182 (*June*, 1955).

As former evidence leaves some doubt as to the mechanism of this decomposition, it was repeated and the mixture analysed spectrometrically. It was shown that hydrogen and acetylene are formed by an intramolecular process, involving the excitation of ethylene by $Hg(^3P_1)$ atoms. A. J. TAYLOR

541.14

8351. Mercury photosensitized decomposition of nitrous oxide. R. J. CVETANOVIĆ. *J. chem. Phys.*, **23**, *No.* 7, 1203–7 (*July*, 1955).

The reaction of nitrous oxide with $Hg(^3P_1)$ atoms at 23°C has been investigated. The evidence obtained indicates that the sole primary process is a splitting of the nitrous oxide molecule into a nitrogen molecule and an oxygen atom. The possible secondary reactions are discussed. A.

541.14

8352. Relative efficiencies of quenching of mercury resonance radiation and their temperature independence. Mechanism of mercury photosensitized decomposition of saturated hydrocarbons. R. J. CVETANOVIĆ. *J. chem. Phys.*, **23**, *No.* 7, 1208–14 (*July*, 1955).

Relative over-all efficiencies of quenching of mercury resonance radiation have been determined for N_2O, n-C_4H_{10}, C_2H_6 and C_2H_4 by studying the binary mixtures of each of the hydrocarbons with nitrous oxide at 23 and 120°C. For N_2O and n-C_4H_{10} the relative efficiency of quenching to the ground state as well as the fractions of quenching to the ground and to the metastable $6(^3P_0)$ state of mercury for each of the two compounds have also been determined. Temperature independence of the primary quenching processes has been demonstrated. A proposed mechanism of quenching by saturated hydrocarbons, based on additional experimental information obtained with n-butane alone and its mixtures with nitrous oxide, interprets fully the experimental facts and in particular accounts for the repeatedly observed low quantum yields of hydrogen formation. A.

541.14

8353. Photolysis of hexafluoroazomethane. J. R. DACEY AND D. M. YOUNG. *J. chem. Phys.*, **23**, *No.* 7, 1302–4 (*July*, 1955).

Hexafluoroazomethane is decomposed by light of 2537 Å to yield nitrogen, hexafluoroethane, perfluorotetramethyl hydrazine and perfluorohexamethyl tetrazine. The relative amounts of the various products vary with the pressure: the compounds of higher molecular weight being produced more abundantly at higher pressures. A free radical mechanism is proposed for the reaction. A.

541.14

8354. Wavelength dependence of photoisomerization equilibria in azocompounds. E. FISCHER, M. FRANKEL AND R. WOLOVSKY. Letter in *J. chem. Phys*, **23**, *No.* 7, 1367 (*July*, 1955).

This was examined for the Hg lines 365, 405, 436, 546 and 578 mμ. The final photoisomeric equilibrium was always independent of the isomeric composition before irradiation. Irradiation with the 254 mμ line always decreased the concn. of the *cis*-isomer obtained with 365 mμ. The *cis-trans* isomeric photoequilibrium is found to be in favour of the isomer with the smaller molecular extinction coeff. W. GOOD

541.14 : 532.528 : 532.7 : 534.321.9

Physico-chemical aspects of chemically active ultrasonic cavitation in aqueous solutions. *See Abstr.* 7790

541.15

8355. Polymerization of methyl methacrylate by γ-rays. A. CHAPIRO AND E. MIGIRDICYAN. Letter in *J. Chim. phys.*, **52**, *No.* 5, 439–40 (*May*, 1955) In French.

The effects of γ-rays from Co^{60} and Ra, giving dosage rates of 0·29 to 410 r/min, are measured dilatometrically up to 7% conversion. Over this range, conversion to polymer is a linear function of time. Rates of reaction and mean molecular weight of polymer produced are plotted logarithmically against dosage rate, I. At low dosage rates, rate of reaction is proportional to $I^{\frac{1}{2}}$, but this relationship does not hold at higher dosage rates. The molecular weight appears to vary as $I^{-0.26}$. These results are compared with those previously obtained with styrene. C. B. ALLSOPP

541.15

8356. Chemical effects of the $C^{12}(\gamma, n)C^{11}$ reaction in anhydrous sodium carbonate. L. J. SHARMAN AND K. J. MCCALLUM. *J. Amer. Chem. Soc.*, **77**, *No.* 11, 2989–92 (*June* 5, 1955).

When sodium carbonate crystals, which have been exposed to γ-radiation from a betatron operating at a peak energy of 23 MeV, are dissolved in water, C^{11} is

found to be present in carbonate, carbon monoxide, formic acid, oxalic acid, glyoxylic acid and glycolic acid. The distribution of C^{11} activity between these compounds has been measured, and found to be independent of twofold variations in the total γ-ray dose or in the dose rate. The distribution is also independent of the pH of the solution in which the crystals are dissolved. The distribution of the C^{11} activity between the two positions of the glyoxylic and glycolic acid molecule has been determined. If the crystals are heated at a series of increasing temperatures before dissolving, the percentage of the C^{11} present as glyoxylic acid, glycolic acid and oxalic acid decreases, each at a different temperature, and the corresponding activity appears instead as carbonate. A mechanism is suggested to account for the experimental results. A.

541.15

8357. X-ray diffraction and chemical examination of some irradiated nucleic acids. K. Little and P. W. Kent. *J. nuclear Energy*, **1**, *No.* 4, 280–5 (*June*, 1955).

Samples of deoxyribonucleic acid in the solid state have been irradiated by X-rays, neutrons and γ-rays, and electrons. The main effect found has been disruption of phosphoric ester linkages. Otherwise the samples were highly radiation-resistant. With very high doses some nitrogen was removed, and an alternative crystal structure was observed. Specimens of *B. lactis aerogenes*, irradiated with X-rays, were found to survive doses greater than those required to reduce the viscosity of aqueous nucleic-acid solutions. A.

541.15

8358. The decomposition of sulphuric acid by cobalt γ-rays. C. J. Hochanadel, J. A. Ghormley and T. J. Sworski. Note in *J. Amer. Chem. Soc.*, **77**, *No.* 12, 3215 (*June* 20, 1955).

SO_2 produced during irradiation of H_2SO_4 solutions was measured by sweeping out with He. SO_2 was not detectable in irradiated solutions containing less than 60% acid. Above this concentration, the rate of production increased with concentration and decreased with increasing dose. Production of SO_2 could be stopped by adding H_2O_2, and was much reduced by sweeping out with O_2 instead of with He. C. B. ALLSOPP

541.15

8359. Heterogeneous catalysis in radiation chemistry. M. Haïssinsky and A.-M. Pujo. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 26, 2530–2 (*June* 27, 1955) In French.

Addition of traces of metallic Ag to aerated solutions of Ag_2SO_4 before irradiation with Co γ-rays increases the value of G for Ag formation from 0·5 to 1·3. Similar results were obtained by addition of metallic Au or of $BaSO_4$. Other radiation chemical reactions, e.g. H_2O_2 production, $FeSO_4$ oxidation, are not affected by the presence of $BaSO_4$. The effect may therefore be associated with the appearance of a solid phase. C. B. ALLSOPP

541.15

8360. The chemical effects of ionising radiation in solids. I. H. G. Heal. *Atomics* [*London*] **6**, *No.* 7, 205–8 (*July*, 1955).

A review article dealing *inter alia* with theories of radiation effects, ionization and excitation in crystals, and general chemical effects; with bibliography. C. B. ALLSOPP

541.15 : 534.23

8361. The effect of ultrasonics on solutions of macromolecules in pyridine. P. Renaud. *J. Chim. phys.*, **52**, *No.* 5, 367–76 (*May*, 1955) In French.

A study of the effect of ultrasonics has shown that while there is no effect on pure pyridine, mixtures of pyridine and water quickly turn brown (just as do solutions of KI) giving off the characteristic odour of carbylamine. It is also shown that the simultaneous application of an ultrasonic and electric field to solutions of polymethyl methacrylate in pyridine produces a break-up of the macromolecule which the ultrasonic field could not produce alone. The possibility of the electric field alone being the cause by an ionization effect is shown to be impossible by separate experiments and one suggestion is made that the effect is due to the alignment of the polar molecules in such a manner as to allow enhanced effect of ultrasonics. The complete explanation is complicated, however, and it can only be concluded that the effect is due to some additive effect of ultrasonics and electric field. T. C. TOYE

DISPERSIONS . COLLOIDS . ADSORPTION

541.18

541.18.04

8362. A theory of the heterocoagulation, interaction and adhesion of dissimilar particles in solutions of electrolytes. B. V. Derjaguin. *Disc. Faraday Soc.*, *No.* 18, 85–98 (1954).

The theory of interaction of charged surfaces in electrolyte solutions based on computing the energy of overlapping of ionic atmospheres has up till now been applied only to the symmetrical case of two equally charged surfaces, or to wetting films with zero charge at their outer boundary when it is easy to reduce this system to the symmetric one. But there exist many phenomena, for instance coagulation of mixtures of sols, coacervation, dyeing, flotation, etc., which require consideration of the asymmetric case of unequally charged surfaces. Using the method of "isodynamic curves" it is possible to obtain the solution of the problem for any electrolyte and any constant value of the surface potentials. The most important property of electric repulsion of surfaces having charges of like signs is the existence of a maximum value of the repulsion at a definite gap-width between both surfaces which is independent of the maximum potentials of both surfaces. This rule holds strictly being independent of the form of either surface. Diverse criteria of stability are found theoretically. Two fundamentally distinct cases should be distinguished according to whether the net result of van der Waals' interactions leads to mutual attraction or mutual repulsion of both bodies—the latter case being impossible when both bodies are similar in material. In the former case a modification of Eilers and Korff's rule is given, which is adapted to the case when one surface remains always strongly charged and the charge of the other one may acquire any value near to

zero. In the other case the adhesion of surfaces or coagulation is only possible when the charges of both surfaces have unlike signs and the electrolyte concentration is not very high. When in addition both surfaces are strongly charged, an equation is obtained giving the critical concentration below which coagulation begins. This equation is very similar in form to that deduced previously and includes the modified Hardy–Schulze's and Wolfe–Ostwald's rules, but in contrast to it contains the valencies of anions and cations symmetrically. Such a reversed Hardy–Schulze's rule is in accordance with the experiments of Frumkin, Gorodetskaja and Titijevskaja on adhesion of mercury drops to glass in electrolyte solutions on dilution. Both these experiments and the theory developed can explain the mechanism of the bipolar coacervation. The present theory of interaction of unlike surfaces is in accordance with many facts in the fields of heterocoagulation and mutual coagulation of sol mixtures. For instance, this theory explains the existence of group coagulation in some cases and disorder coagulation—in other ones, the fixation of dye particles prior to the onset of homogeneous coagulation, and many other phenomena. A.

541.18.04

8363. Kinetics of the coagulation of emulsions. A. S. C. Lawrence and O. S. Mills. *Disc. Faraday Soc., No.* 18, 98–104 (1954).

The rate of coalescence of oil droplets in water and in soap solution has been investigated by size frequency distribution measurements using an improved photomicrographic method. The results are analysed in terms of the von Smoluchowski theory of coagulation kinetics and the presence of an energy barrier to coalescence demonstrated. A.

541.18.04

8364. The coagulation of non-spherical particles. F. Booth. *Disc. Faraday Soc., No.* 18, 104–12 (1954).

Using Smoluchowski's model of a diffusion process, a quantitative theory for the mutual coagulation of two kinds of particles, either or both of which may be spheroidal, is developed. It is shown that fairly exact expressions for the mutual coagulation rate can be given if the two types of particle differ appreciably in size. The generalization of the theory to include long-range interaction between the particles is given. A.

541.18.04

8365. Coagulation and thixotropic structures. P. Rehbinder. *Disc. Faraday Soc., No.* 18, 151–60 (1954).

A study of the conditions of formation and the mechanical and thixotropic properties of three-dimensional coagulation and condensation structures has shown that coagulation structures, contrary to condensation ones, possess a perfect thixotropic reversibility. They reveal not only plastic flow, but also, in the pseudoelastic region at the lowest possible stresses, a peculiar creep in an undisturbed structure with a Newtonian viscosity of the order of 10^7–10^9 poises, for dilute bentonite suspensions, which is 10^8 higher than the minimum viscosity of a disturbed structure. These remarkable features of thixotropic coagulation structures are closely connected with the residual liquid layers at the points of cohesion of particles forming the network. A.

541.18.04 : 532.65

The effects of humidity deficit on coagulation processes and the coalescence of liquid drops. *See Abstr.* 7739

541.18.04 : 539.13

Investigations of the forces of interaction of surfaces in different media and their application to the problem of colloid stability. *See Abstr.* 8109

541.182.4

8366. Electron microscopy of monodisperse latexes. E. B. Bradford and J. W. Vanderhoff. *J. appl. Phys.*, **26,** *No.* 7, 864–71 (*July*, 1955).

A series of monodisperse polystyrene latexes was prepared by carefully controlled emulsion polymerizations. The particle diameters of three of these latexes were determined by electron microscopy. The latex particles were dispersed on collodion membranes supported by copper grids. The microscopes had previously been calibrated with collodion replicas of a 30 000 line/inch diffraction grating. In general, the reproducibility of measurements from many photographic exposures was good; however, a few exposures yielded particle diameters considerably higher than the averages. An investigation of this technique indicated that: (1) polystyrene latex particle diameters (collodion membranes—copper grid supports) increased considerably on electron irradiation, (2) collodion diffraction grating replicas (copper grid supports) shrank slightly on electron irradiation, and (3) the magnification of the electron microscope varied slightly from exposure to exposure. It was found that variations of particle diameter resulting from the foregoing sources of error were negligible when the particles were dispersed directly on a silicon monoxide diffraction grating replica supported by a stainless steel grid. The particle diameters of the latexes determined in this manner ranged from 880 to 11 720 Å. Many photographic exposures of each latex were used for these measurements. The monodispersity of the latex particles is evident from the small values of the standard deviations of the over-all particle-size distributions. The reproducibility of particle diameters determined from different exposures is evident from the small values of the standard deviations of the means of the exposure averages. A.

541.182.4 : 537.36

8367. Motion of water droplets of an emulsion in a non-uniform field. C. Bezemer and G. A. Croes. Note in *Brit. J. appl. Phys.*, **6,** *No.* 6, 224–5 (*June*, 1955).

Migration of water droplets towards the strongest part of an electric field has been observed in a 0·1% emulsion in oil, in contrast to Pearce's results for a 10% concentration [Abstr. 6091 (1954)].

J. G. OLDROYD

541.183

8368. Sorption and surface diffusion in microporous carbon cylinders. R. M. Barrer and E. Strachan. *Proc. Roy. Soc. A*, **231,** 52–74 (*July* 19, 1955).

An investigation has been made of adsorption and diffusion of helium, neon, hydrogen, argon, nitrogen

and krypton in microporous cylinders of carbon compressed to different porosities ε, and having very high internal surfaces, A. On the uncompressed carbon powder sorption of argon occurred at 90 and 78°K without hysteresis; in a compressed cylinder with $\varepsilon = 0{\cdot}64\,cm^3$ per cm^3 and $2\varepsilon/A = 18{\cdot}8$ Å the isotherms changed from type II to type IV in Brunauer's classification and a pronounced hysteresis loop appeared. In a highly compressed cylinder with $\varepsilon = 0{\cdot}37\,cm^3$ per cm^3 and $2\varepsilon/A = 6{\cdot}5$ Å hysteresis again disappeared and the isotherms changed from type IV nearly to type I. The areas A and heats of sorption were measured, and special attention was paid to sorption equilibria involving dilute films of nitrogen, argon and krypton between 273 and 323°K. Surface and volume diffusion were then investigated over the same temperature interval, 273 to 323°K, in the compressed cylinders already carefully characterized by the equilibrium studies. Surface diffusion coefficients, D_s, were evaluated for all the gases including helium. The properties of D_s indicate that dilute films of helium, neon and hydrogen are best regarded as one- or two-dimensional gases but that argon, nitrogen and krypton still give localized adsorbed films in which surface flow is by jumps, each unit diffusion requiring an energy of activation which was 0·53 to 0·62 of the heat of adsorption. It was further shown that adsorption isotherms in the Henry's law region can be measured by flow methods, and are in agreement with those obtained by direct measurement. The surface diffusion coefficients increase and the activation energies for diffusion decrease for argon, nitrogen and krypton as the surface concentration of adsorbate increases. In some cases, especially for krypton, surface flow was much the most important mode of transport within the micropore system. A.

541.183 : 537.213

Determination of the surface potential of some films on tungsten and mercury. *See Abstr.* 7935

541.183 : 537.533

8369. On the adsorption of oxygen on tungsten as revealed in the field emission electron microscope. J. A. Becker and R. G. Brandes. *J. chem. Phys.*, **23**, *No.* 7, 1323–30 (*July*, 1955).

The tungsten surface in a field emission microscope is exposed to oxygen gas at a pressure near 5×10^{-8} mm and the effect of the gas on the field emission is observed. During the first 30 sec, the emission decreases rapidly, but some regions deactivate more rapidly than others. During the next 12 min, the rate of deactivation is much slower, but again the change in activity for some planes is much more pronounced than for others. After the surface is heavily covered, the oxygen is desorbed by glowing the tungsten for one minute at successively higher temperatures. The chief conclusions are: Oxygen is adsorbed on tungsten in three stages or layers. In the first layer, the bond strength is about 5 electron volts and the oxygen cannot be removed below about 1 500°K. In the second layer, the bond strength is about 2·5 eV and the oxygen cannot be removed below about 750°K. These bond strengths depend somewhat on the crystallographic plane. In the third layer, the oxygen forms a variety of molecular complexes with the substrate. These reveal themselves as intensely bright, highly localized groups of spots. Each spot is due to electrons emitted by individual atoms in a molecule. The conditions necessary to observe such adatoms are given. A.

541.183 : 548.7

8370. Surface adsorption and migration energies for KCl. J. E. Hove. *Phys. Rev.*, **99**, *No.* 2, 430–4 (*July* 15, 1955).

The binding and migration energies for a K^+ ion on a (100) KCl surface are calculated. It is found that the most stable K^+ site is about an interionic lattice spacing above a Cl^- surface ion and the binding energy is 0·68 eV. The activation energy for lateral diffusion is 0·23 eV and the estimated vibration frequencies are $10^{12}\,sec^{-1}$ along the surface and $2{\cdot}8\times10^{12}\,sec^{-1}$ normal to the surface. From these figures it is shown that the mean path length of the ion is about 2×10^{-4} cm; the binding energy for an absorbed KCl molecule is found to be about 0·36 eV. This leads to the conclusion that the molecule will travel at most a few lattice spacings before evaporating. Some effects of this on crystal growth and additive colouring are discussed briefly. A.

CHEMICAL STRUCTURE 541.2/.6

541.23

8371. Determination of the atomic weight of silicon by physical measurements on quartz. C. Frondel and C. S. Hurlbut, Jr. *J. chem. Phys.*, **23**, *No.* 7, 1215–19 (*July*, 1955).

The value $28{\cdot}095 \pm 0{\cdot}005$ for the atomic weight of silicon has been obtained through precision measurements of the density and unit-cell volume of an unusually pure crystal of natural quartz, SiO_2. The value is based on the Avogadro number, 6·023 38, and wavelength conversion factor, 1·002 030, of Birge (1945). The following experimental data were obtained: density in g/cm^3 in vacuum at 25°, $2{\cdot}648\,47 \pm 0{\cdot}000\,1$; unit-cell dimensions in kX at 25° and corrected for refraction, a_0 4·903 60, c_0 5·394 17, both $\pm0{\cdot}000\,1$; indices of refraction for λ589·29 mμ at 18°, nO 1·544 258, nE 1·553 380, both $\pm0{\cdot}000\,01$; inversion temperature 573·3° on both heating and cooling cycles. Direct analysis gave (weight percent): Li_2O 0·000 5, Na_2O 0·000 4, K_2O 0·000 2, Al_2O_3 0·000 8, TiO_2 0·000 1, MnO_2 0·000 02, Fe_2O_3 0·000 0. The major systematic errors in this method stem from compositional variation in the quartz, of the nature of a coupled substitution of Al for Si with interstitial (Li,Na), and probably lead to a high value for the atomic weight. For purposes of comparison, data are also given for smoky quartz, rose quartz, and a synthetic quartz containing much Al and Li in solid solution. A.

541.5 : 539.132

8372. On a method for the calculation of bond orders. I. Samuel. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 21, 2075–6 (*May* 23, 1955) In French.

An expression is derived for the calculation of bond orders, starting from the definition of Coulson and Longuet-Higgins. A. J. TAYLOR

541.64 : 538.612

8373. On the magnetic birefringence of tobacco mosaic virus. F. Debot. *Bull. Soc. Roy. Sci. Liège*, **24**, *No.* 2–3, 48–51 (*Feb.–March*, 1955) In French.

Measurements of the birefringence of tobacco mosaic virus in suspension in water have been carried out using a magnetic field of 20 000 gauss.

G. I. W. LLEWELYN

541.67

8374. Magnetic study of tetra-alkyl-germanes. P. Mazerolles and D. Voigt. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 22, 2144–6 (*June* 1, 1955) In French.

The molar magnetic susceptibilities of a series of tetra-*n*-alkyl-germanes $Ge[(CH_2)_nH]_4$, for values of n from 1 to 8, have been measured by the Gouy method. The susceptibility of the Ge atom is found to decrease with increasing values of n to a limiting value approximating to the measured susceptibility of the powdered metal.

G. I. W. LLEWELYN

CHEMICAL ANALYSIS 543/545

545.827

8375. The estimation of trace amounts of barium or strontium in biological material by activation analysis. G. E. Harrison and W. H. A. Raymond. *J. nuclear Energy*, **1**, *No.* 4, 290–8 (*June*, 1955).

A neutron activation method is described for the estimation of barium or strontium in biological materials which is not disturbed by the presence of a large excess of calcium. The method is a comparative one in which a weighed amount of a pure barium or strontium salt receives the same neutron irradiation in a nuclear pile as a weighed aliquot from the unknown specimen. Following a chemical separation, the activity of the barium or strontium fraction from the unknown is compared with that from the appropriate standard. The error of the method is estimated to be about 5% in specimens containing from 1 to 50μg of either element.

A.

CRYSTALLOGRAPHY 548

548.1 : 537.228.1 : 539.31

8376. Study of crystalline elasticity and piezoelectricity. III. Atomic theory of elasticity and piezoelectricity. IV. Atomic theory of the piezoelectricity of blende. Y. Le Corre. *Bull. Soc. Franç. Minéral. Crist.*, **78**, *No.* 1–3, 33–83 (*Jan.–March*, 1955) In French.

For Pt II, see Abstr. 5075 (1955). Laval's atomic theory of crystalline elasticity is applied to piezoelectric crystals and as before it is shown that there are 27 piezoelectric constants and not 18, as in Voigt's theory. The author's observations on wave propagation in ammonium phosphate crystals agree with those calculated by Laval's theory but not by Voigt's theory. The atomic theory is applied to a study of ZnS; the displacement of the Zn and S ions modifies the normal Cauchy relation and affects the piezoelectric constant.

H. J. H. STARKS

548.1 : 550.3 : 539.31

On the symmetries of physical properties. Application to crystallography. *See Abstr.* 8315

548.5

8377. On the process of crystal growth. W. Kossel and K. Walz. Letter in *Naturwissenschaften*, **42**, *No.* 10, 296 (1955) In German.

During the electrolytic growth of silver filaments with a current of about 10^{-9}A, current pulses of some 0·01 sec duration were detected, indicating the discontinuous nature of the growth process. The filaments contained kinks and bends but maintained a single crystallographic orientation throughout.

J. FRANKS

548.5

8378. Stratified removal of the (001) face of natural and artificial sodium chloride. Electron microscope observations. R. Hocart, G. Roult and A. Oberlin (Mathieu-Sicaud) *C.R. Acad. Sci.* [*Paris*] **240**, 2245–6 (*June* 6, 1955) In French.

The cleavage face of a sodium chloride crystal was etched in water for short periods, and the resulting structure examined in the electron microscope. Discontinuities in the dimensions of the etch figures, particularly in the heights and widths of the plateaux formed, suggest removal of the material in layers composed of packets of planes.

A.E.I. RESEARCH LABORATORY

548.5

8379. On the distribution of impurity in crystals grown from impure unstirred melts. K. F. Hulme. *Proc. Phys. Soc. B*, **68**, *Pt* 7, 393–9 (*July*, 1955).

The existence of a boundary layer of different impurity concentration on the solid-melt interface during crystal growth into impure unstirred melts has been inferred by previous authors. The problem of how rapidly this layer attains its final form in the case of growth into an infinite unstirred melt, hitherto treated approximately, is shown to be capable of exact solution for all values of the segregation constant. The impurity distribution in the resultant solid is calculated and graphs are given for various values of the segregation constant.

A.

ATOMIC AND X-RAY CRYSTALLOGRAPHY 548.7

548.7

8380. The electrostatic part of the lattice energy of the perovskite lattices. P. Brauer. Note in *Z. Naturforsch.*, **10a**, *No.* 5, 420–1 (1955) In German.

This can be used to find all possible compounds ABX_3 crystallized in a perovskite lattice. The Madelung numbers for the seven possible combinations AB are calculated.

C. TURNER

548.7

8381. Average crystal potential. J. L. BIRMAN. Letter in *Phys. Rev.*, **98**, *No.* 6, 1863–4 (*June* 15, 1955).

It is shown that the Frenkel–Bethe formula for the average potential in an infinite non-ionic crystal can be obtained from the Fourier representation of the total crystal potential. This average potential is primarily determined by the valence electron density. The analysis is not obviously applicable to ionic crystals, but should apply to the neutral complex (treated separately from the excess or deficiency of charge). A. J. KENNEDY

548.7 : 534.23

Relaxations in the attenuation of single crystal lead at low temperatures and the relation to dislocation theory. *See Abstr.* 7786

548.7

8382. Thermal and non-radiative transitions of electrons at imperfections in ionic crystals. M. TRLIFAJ. *Czech. J. Phys.*, **5**, *No.* 2, 133–59 (*April*, 1955).

The theory is elaborated and the results obtained are used to confirm Mott's and Gurney's theories on the detachment process in two steps of electrons from *F*-centres during the absorption of light in the *F*-band and to explain theoretically the temperature dependence of quantum efficiency. Good agreement with experiment was obtained. The possibility of the luminescence of alkali halide crystals containing *F*-centres at sufficiently low temperatures was also determined. A.

548.7

8383. Physical properties of the alkali halide crystals. F. SEITZ. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 95–103 (1955).

A survey of the current position of knowledge of alkali halides is given. Defects in alkali halides are of Schottky type and have been precisely studied by divalent ion addition causing association of vacancies with the latter. Further advance has been made by study of dislocations in the halides. *F*-centre studies of importance include those of spin resonance and bleaching of *F*-centres in relation to plastic deformation. *V*-centres have proved to be more complex than *F*-centres and several *V* absorption bands are known with different thermal stabilities. A dearth of studies on *V*-centres in the absence of *F*-centres is noted. An important aspect of coloration in the halides is that involving centres due to divalent ion additions. G. F. J. GARLICK

548.7

8384. Calculations on the interactions between equilibrium defects in the alkali halides. F. BASSANI AND F. G. FUMI. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 114–17 (1955).

The interactions of positive and negative ion vacancies and of positive ion vacancies and divalent impurity ions are considered. Substitution of polarizabilities for ions in an alkali-halide lattice for those of free halide ions used in previous calculations shows that over all distances except at close approach the interaction energy is Coulombic. G. F. J. GARLICK

548.7

8385. Preliminary experiments on the Kirkendall effects in alkali halide crystals. G. CHIAROTTI AND F. G. FUMI. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 118–21 (1955).

A mixed crystal of (K,Rb)Cl is coated with a crystal layer of KCl, fine Pt wires being included at the interface to measure shifts during annealing at 600°C for 5–30 days. The marker wires shift towards the mixed crystal (lower melting point) as predicted by the rule for Kirkendall shifts. G. F. J. GARLICK

548.7

8386. Annealing of point defects in metals and alloys. W. M. LOMER AND A. H. COTTRELL. *Phil. Mag.*, **46**, 711–19 (*July*, 1955).

An analysis is made of published data on the recovery of resistivity during the annealing of metals at low temperatures, after damage by irradiation, quenching, or cold work. Interpreted in terms of the migration and annihilation of point defects, the experimental observations show two annealing stages, in the second of which the number of migratory jumps made by a defect before annihilation appears anomalously small. It is suggested that during the first stage some of the defects become trapped (e.g. on impurity atoms), and that the second stage is concerned with the evaporation of these defects from their traps; this leads to a reasonable number of jumps for the second stage. The theory is applied to some results of quenching experiments by Roswell and Nowick. Finally, it is pointed out that the unexpectedly large number of jumps observed in stage 1 annealing, after irradiation or cold work, can be accounted for if the interstitial mechanism provides a random walk in only one dimension, as in the case of "crowdions." A.

548.7

8387. Fields around impurity atoms in metals. L. C. R. ALFRED AND N. H. MARCH. *Phil. Mag.*, **46**, 759–68 (*July*, 1955).

Detailed calculations of the potential around impurity atoms with valency $Z + 1$ dissolved in a monovalent metal are reported. The first order or linearization approximation usually employed is avoided, and the basic Thomas–Fermi equation must then be solved numerically. The potentials thus obtained differ significantly from those predicted by the first order approximation. The differences are always in the direction of a more effective shielding of the point charge Ze. The shielding depends appreciably on the valency of the dissolved impurity, whereas the first order result is a screened potential with a screening radius independent of Z. The connection between the present results and Friedel's second order approximation is briefly discussed. The calculations have then been extended to cover the case dealing with a finite concentration of impurities, using the model of Friedel. Again it is found that the results given by the first order approximation are appreciably in error. In all the numerical calculations copper is taken as the solvent metal; the essential conclusions will, however, hold more generally. A.

548.7

8388. A calculation of the density of electron-trapping defects in neutron-irradiated graphite from measurements of the temperature variation of the Hall coefficient. D. F. JOHNSTON. *J. nuclear Energy*, **1**, *No.* 4, 311–18 (*June*, 1955).

A model for the Hall effect in graphite is described. Theoretical curves are given for 200 and 300°K relating the Hall coefficient for a single crystal to the number of electrons trapped. The density of electrons (n/cm^3) trapped in irradiated graphite is deduced from the observed Hall coefficient, and found to be about $2{\cdot}8\times10^{19}$ per cm^3 at 200°K, and about $3{\cdot}4\times10^{19}$ per cm^3 at 300°K after a dose of 5×10^{19} thermal neutrons per cm^2. The chemical potential ε_0 for a single crystal is calculated in terms of the temperature, and the density of trapped electrons. The effect of spin and orbital degeneracy w on the occupation of the trapping sites is considered. The density of electron-trapping defects N is first discussed, assuming a single trapping energy level ε_t in terms of a relation of the form

$$N = n\left[1 + (2w)^{-1}\exp\left(\frac{\varepsilon_t - \varepsilon_0}{kT}\right)\right]$$

where ε_t is found empirically from the temperature variation of n. The effect of more than one kind of trapping site is then considered. The various sources of error in an estimate of N are reviewed. Finally the probable value of N after a dose of 5×10^{19} thermal neutrons/cm^2 is estimated to be about 1×10^{20} electron-trapping defects per cm^3. A.

548.7

8389. Experimental evidence for thermal spikes in radiation damage. W. PRIMAK. Letter in *Phys. Rev.*, **98**, *No.* 6, 1854–5 (*June* 15, 1955).

The acceleration of the rate of increase of specific volume of quartz under neutron irradiation is attributed to an increase in the efficiency of thermal spikes consequent upon the radiation-induced decrease in thermal diffusivity. W. M. LOMER

548.7

8390. X-ray measurements on low-temperature neutron-irradiated graphite. D. T. KEATING. Letter in *Phys. Rev.*, **98**, *No.* 6, 1859–60 (*June* 15, 1955).

Natural graphite compacted into highly oriented briquettes was irradiated up to a maximum exposure of $4{\cdot}0\times10^{19}$ nvt integrated flux at −196°C. The fractional change in c-axis spacing ($\Delta c/c$) exhibits a discontinuity when plotted against integrated flux. The X-ray reflections broaden: the $K_{\alpha1}$ peak shifts (corresponding to the c-axis change) and reduces in height after radiation. The general conclusion is that more damage is retained in the graphite at this temperature than at 30°C. A. J. KENNEDY

548.7

8391. Production and destruction of α centres in KBr crystals. H. RÜCHARDT. *Z. Phys.*, **140**, *No.* 5, 547–64 (1955) In German.

The formation of α-centres by X-ray irradiation at low temperatures and the thermal stability of the α-centres is studied in detail. Yield of α-centres is approximately independent of X-ray energy and dose over the range studied with most favourable formation for 1 keV X-rays. Yield is larger for crystals with Cl^- ion addition and initial rate of production rises with decreasing temperature, particularly rapidly below 20°K. The centres disappear with rising temperature the bleaching curve being complex. Explanations of detailed results are given in terms of the Seitz model [Abstr. 9755 (1954)]. G. F. J. GARLICK

548.7

8392. The influence of ultra-violet irradiation on the absorption in the infra-red region of KBr and KI crystals with anionic impurities. W. WARDZYŃSKI. *Bull. Acad. Polon. Sci. Cl.* 3, **3**, *No.* 3, 169–73 (1955).

KNO_3 in KBr gives bands at 7·12 and 7·76 μ, KCO_3 gives a 6·9 μ in addition to the bands for KNO_3. Ultraviolet irradiation decreases the 7·12 μ band and increases the 7·76 μ band intensity. For KI bands at 6·8 and 7·12 μ are found with no impurity added. Ultraviolet irradiation has similar effects to those in KBr. At room temperature the u.v. effects are stable but restoration of the 7·12 μ band occurs at high temperatures. G. F. J. GARLICK

548.7

8393. Color center reactions. A. B. SCOTT. *Nuovo Cimento Suppl.* (*Ser.* 10) **1**, *No.* 2, 104–11 (1955).

A critical discussion of the deficiencies in quantitative evidence on F-centres. Kleinschrod's determination of oscillator strength for the F-centre is called in question. The following reactions are considered in detail:—conversion of F- to N-centres, formation of F'-centres, conversion of F- to Z_1- and Z_2-centres and coagulation of F-centres into the colloidal state. It is suggested that a precise thermodynamic basis for reactions in solutions is not likely to be achieved for colour centres in alkali halide crystals. G. F. J. GARLICK

548.7

8394. Chemical effects associated with "colour centres" in alkali halides. W. G. BURNS AND T. F. WILLIAMS. Letter in *Nature* [*London*] **175**, 1043–4 (*June* 11, 1955).

Relatively large concentrations of colour centres are produced in NaCl crystals by irradiation with electrons from a Van de Graaff generator. The centres are stable over a period of four weeks and "excess" and "defect" concentrations are found to be equivalent. The absorption spectrum of an irradiated-cooled crystal indicates the formation of well-defined F- and M-bands. Uncooled, the crystal shows a spectrum in which instead of the F- and M-bands a new band, the colloidal one, appears. Crystals containing a high concentration of colour centres are able to initiate the polymerization of acrylonitrile in aqueous solution. W. GOOD

548.7

8395. Optical bleaching of F centers in X-rayed alkali halide crystals. R. HERMAN AND R. F. WALLIS. *Phys. Rev.*, **99**, *No.* 2, 435–42 (*July* 15, 1955).

When F light is absorbed by F-centres it is assumed that electrons leave negative ion vacancies and are transferred to the conduction band. Conduction electrons may be captured by holes and by negative ion vacancies. It is assumed that the cross-sections

for the latter two processes are equal and that the conduction electron concentration is small and stationary. Under these conditions the local *F*-centre concentration, n, is specified by the equation $\partial n/\partial t = -bIn^2$, where I is the local *F*-light intensity assumed to be given by the Beer–Lambert law and b is a constant. Exact expressions for n and I have been obtained for the case of a uniform initial *F*-centre distribution. The theoretical results are compared with quantitative measurements of the *F*-centre concentration as a function of *F*-light irradiation time in X-rayed NaCl for a range of incident light intensities and initial *F*-centre concentrations. It is found that the behaviour of the model is consistent with experimental data in lightly X-rayed crystals having initial concentrations in the range $\sim 10^{16}$–$\sim 10^{17}\,cm^{-3}$. In more heavily X-rayed crystals, appreciable growth of *M* and *R* bands occurs during the bleaching and deviations from the behaviour of the model are observed. A.

548.7 : 538.221

8396. On the maze domain of silicon-iron crystal. I. S. CHIKAZUMI AND K. SUZUKI. *J. Phys. Soc. Japan*, **10,** *No.* 7, 523–34 (*July*, 1955).

By using powder pattern technique, the maze-like domain which appears on the mechanically polished surface of Si–Fe crystal was examined. The maze domain was found to be of the closure type, which transports the magnetic flux of the underlying domains. It was also found that the boundaries between these domains are zigzag-shaped. This is interpreted as a general character of 90° wall. The agreement between theory and experiment is good. The degree of zigzag depends also upon the magnitude of the internal stress. From this relation the internal stresses up to 360 kg/mm^2 was found in the vicinity of the scratch. A.

548.73/.74

X-ray and electron investigation of materials. *See also under* "Structure of solids." Decimal classification 539.26/.27

548·732

8397. Debye–Scherrer interference for Bragg-angles of about 85°. V. HAUK AND J. HAUK. *Z. angew. Phys.*, **7,** *No.* 7, 321–3 (1955) In German.

Shapes of curves of the lines occurring on flat stationary film when the specimen (back radiation) is rotated for Bragg-angles around 85° are calculated for any position of film and back radiating surface and compared with experimental data. C. TURNER

548.732

8398. X-ray path through calcite in Laue diffraction. G. L. ROGOSA AND G. SCHWARZ. *J. appl. Phys.*, **26,** *No.* 8, 967–9 (*Aug.*, 1955).

The position and width of the X-ray beam transmitted through calcite in Laue diffraction has been measured. For the extinction case, the transmitted beam has the same position and width as the incident beam. For the anomalous transmission case, the transmitted beam widens showing that the radiation propagates through the crystal along the diffracting planes. These results are in general accord with the theoretical calculations of von Laue. A.

548.732 : 537.531 : 535.34

8399. Contribution to the study of the absorption of X-rays by quartz crystals in the neighbourhood of the Bragg angle. G. BARRÈRE. *C.R. Acad. Sci.* [*Paris*] **240,** *No.* 19, 1907–9 (*May* 9, 1955) In French.

See Abstr. 7868 (1954). Describes observations, in agreement with theory, on crystal plates of medium thickness ($\simeq 2/\mu$). A. R. STOKES

548.733

8400. A high-intensity focusing system for structure determination with the counter-tube goniometer. G. FROHNMEYER AND H. RICHTER. Letter in *Naturwissenschaften*, **42,** *No.* 9, 256–7 (1955) In German.

Describes an asymmetrical focusing arrangement, with the counter-tube following the focus position as the specimen is rotated. A. R. STOKES

548.733

8401. Reflected beam X-ray monochromator for Geiger counter diffractometry. B. R. BANERJEE. *Rev. sci. Instrum.*, **26,** *No.* 6, 564–5 (*June*, 1955).

A bent-crystal monochromator, for Geiger-counter diffractometry, was constructed to monochromate the specimen-reflected X-ray beam. This results in very low backgrounds, due to the elimination of fluorescent scattering from the specimen. Adequate resolution and diffracted energy were obtained. A.

548.733

8402. Pseudo-precession photographs from an oscillation camera. W. E. LOVE AND D. SAYRE. Letter in *Rev. sci. Instrum.*, **26,** *No.* 6, 621–2 (*June*, 1955).

Describes the construction and use of a simple layer-line screen, which oscillates with the crystal, enabling one to obtain some of the 0*kl* reflections and some of the 1*kl* reflections on one film. A. R. STOKES

548.733

8403. An integrating mechanism for the Buerger precession camera. C. E. NORDMAN, A. L. PATTERSON, A. S. WELDON AND C. E. SUPPER. *Rev. sci. Instrum.*, **26,** *No.* 7, 690–2 (*July*, 1955).

A Buerger precession camera has been provided with an integrating mechanism of the type designed by Wiebenga and Smits for the Weissenberg camera. The integrating motion is conveyed to the film holder directly by eccentric cams geared to the precession drive of the camera. Photographs taken with this instrument allow the recording of the integrated intensities and background for all the reflections of any row line in a single run of an automatic recording photometer. A.

548.733

8404. Focusing transmission specimen technique for the X-ray diffractometer. A. R. LANG. *Rev. sci. Instrum.*, **26,** *No.* 7, 680–9 (*July*, 1955).

A multiple non-parallel receiving slip assembly enables diffraction patterns combining high intensity with good resolution to be obtained from transmission specimens using primary beam divergencies of several degrees. Analysis of line profiles from specimens set for symmetric and asymmetric transmission indicates advantages of the method for low angle diffraction and preferred orientation studies. A.

548.734

8405. Domain of reciprocal space accessible to precession photography. G. DONNAY AND J. D. H. DONNAY. Letter in *Rev. sci. Instrum.*, **26**, *No.* 6, 610–12 (*June*, 1955).

It is pointed out that the published tables of the Lorentz polarization factor [Abstr. 8569 (1952)] for upper level photography do not cover the whole region of reciprocal space which is accessible by this method. A. R. STOKES

548.734

8406. Some comments on upper level precession photography. R. D. BURBANK. Letter in *Rev. sci. Instrum.*, **26**, *No.* 6, 612–13 (*June*, 1955).

See preceding abstract. While it is true that the Lorentz-factor tables do not cover the whole range of the precession camera, it is claimed that they cover the useful range, a sphere of radius 1 reciprocal-lattice unit about the origin as centre. A. R. STOKES

548.734

8407. Effect of particle-size on the quantitative determination of quartz by X-ray diffraction. R. L. GORDON AND G. W. HARRIS. Letter in *Nature* [*London*] **175**, 1135 (*June* 25, 1955).

548.735

8408. Application of Eller's optical machine to the determination of crystal structures. L. BRÜ, M. PÉREZ RODRÍGUEZ AND A. L. CASTRO. *An. Real. Soc. Españ. Fis. Quim.*, **51(A)**, *No.* 5–6, 115–20 (*May–June*, 1955) In Spanish.

See Abstr. 5002, 8352 (1951). Demonstrates the possibility of obtaining the Buerger's image-seeking functions and also, with a modification of the machine, the calculation of the signs of the structure factors. An application of the method proposed by Woolfson for permutation synthesis is also described. A.

548.735

8409. Investigations of the Fourier transforms of X-ray scattering curves. G. BREITLING, F. HERRE AND H. RICHTER. Note in *Naturwissenschaften*, 42, *No.* 6, 151–2 (1955) In German.

Radial Fourier transforms of X-ray scattering curves for graphite are compared with calculated radial distribution curves for single layers and for double layers. A. R. STOKES

548.735

8410. Influence of the degree of perfection of a crystal on the intensity of Bragg reflection. I. Measurements with calcite and rocksalt. K. S. CHANDRASEKARAN. *Proc. Indian Acad. Sci. A*, **41**, *No.* 5, 185–91 (*May*, 1955).

Describes the study of the texture of crystals by using polarized X-rays. Some measurements on specimens of calcite and rocksalt are reported here and it is found that the relative intensities of various reflections and also the variation of the intensities of a particular reflection with the degree of perfection are broadly in agreement with the expectations from theory. A.

548.735

8411. New method in X-ray crystal structure determination involving the use of anomalous dispersion. Y. OKAYA, Y. SAITO AND R. PEPINSKY. Letter in *Phys. Rev.*, **98**, *No.* 6, 1857–8 (*June* 15, 1955).

Patterson series are constructed for non-centrosymmetric crystals containing anomalous scattering atoms. For a small number of anomalous scattering atoms these can be used for structure determination. An application on $[d\text{-Co}(en)_3]Cl_3.NaCl.6H_2O$ was successful. C. TURNER

548.736.1

8412. Changes in the fine structure of cobalt. A. KOCHANOVSKÁ. *Czech. J. Phys.*, **5**, *No.* 2, 201–13 (*April*, 1955) In Russian.

Changes in the fine structure of cobalt caused by dry-grinding were studied by the X-ray diffraction method. The material used was obtained by the reduction of cobaltous formate and according to X-ray investigation was formed predominantly by the cubic modification (90%). It was shown that at lower degrees of grinding the original cubic modification changes to the hexagonal modification which has stacking faults. At the same time the mutual distance of the basic planes $[(111)_K$ or $(001)_H]$ decreases. In this stage of plastic deformation by grinding most probably a spontaneous homogeneous transformation is involved. At higher degrees of grinding notable defects of the second kind (microstresses) are produced and the hexagonal modification which was formed in the preceding process, again begins to change to cubic. This second change can be explained either by the formation and concentration of growing faults as a result of the growth of the crystallites, or by the spontaneous change which takes place as a result of the considerable local increase in temperature and which due to lattice impurities caused by oxygen or due to the production of defects of the third kind becomes irreversible. At the same time a covering of very fine crystalline cobalt oxide is formed on the surface of the crystallites in the second stage of the grinding process. The investigation both of the original and the ground cobalt by differential thermal analysis in reducing and oxidating surroundings showed that the changes determined in the fine structure can have a substantial effect on the course of some physico-chemical processes. A.

548.736.1 : 539.32

8413. The determination of the elastic constants of silicon by diffuse X-ray reflexions. S. C. PRASAD AND W. A. WOOSTER. Letter in *Acta cryst.*, **8**, *Pt* 6, 361 (*June*, 1955).

Values of elastic constants were deduced from measurements, made with a Geiger-counter spectrometer, of distributions of intensity along three lines in reciprocal space all passing through the reciprocal lattice point 400. A. R. STOKES

548.736.4

8414. Synthesis and identification of two double oxides of tantalum and tin. M. GASPERIN. *C.R. Acad. Sci.* [*Paris*] **240**, *No.* 24, 2340–2 (*June* 13, 1955) In French.

548.737

8415. Dimorphism of *para*-dichlorobenzene. G. A. JEFFREY AND W. J. MCVEAGH. *J. chem. Phys.*, **23**, *No.* 6, 1165–6 (*June*, 1955).

As previous evidence on transition temperatures of

paradichlorobenzene was conflicting, crystals of this substance were investigated optically and by X-rays. The existence of a high-temperature β-form was confirmed. This form was found to be triclinic, and the cell constants could be calculated. The unit cell of the monoclinic α-form which exists at room temperature has double the volume and two molecules.

A. J. TAYLOR

548.74

8416. Basal reflection of electron waves by orientated aggregates of clay minerals. R. P. MITRA AND M. V. R. K. RAO. Note in *Naturwissenschaften*, **42**, *No.* 5, 119–20 (1955).

Considers the circumstances in which electron reflection from the basal plane of clay minerals is observable. J. THEWLIS

GEOPHYSICS 55

550.3 : 548.1 : 539.31

On the symmetries of physical properties. Application to geophysics. *See Abstr.* 8315

ATMOSPHERE . METEOROLOGY 551.5

551.508.21

8417. A sensitive electronic tele-pyranometer with temperature-compensated capacitance bolometers. H. J. ALBRECHT. *Geofis. pura appl.*, **30**, *No.* 1, 93–105 (1955).

A complete tele-pyranometer system whose remote unit comprises a radiation-sensitive oscillator, a temperature-compensating oscillator and a transmitting section operating on a frequency equal to the intermediate frequency of the two. As it was developed especially for airborne use, the remote unit may be as far as 200 to 1 000 miles from the base station, the maximum distance being solely governed by the capability of the transmitting section and by the ionospheric propagation conditions. Comments are also made on the base station for the reception and actual reading of the pyranometer signal. In addition, various applications for this new capacitance bolometer principle are mentioned in anticipation of detailed descriptions of other apparatus based upon the principle, at a later date. A.

551.508.91

8418. A new method of condensation nucleus counting. W. WIELAND. *Geofis pura appl.*, **30**, *No.* 1, 137–43 (1955) In German.

A method which allows droplets of condensation nucleus or other droplets (diameter 5 μ) to be forced by means of varnished plates of glass and counted electronically. Preliminary experiments with this method show the probability, that in the nucleus counter, working on the principle of expansion, some of the very active nuclei fall before the expansion chamber is dilated and thus escape registration. A.

551.508.94

8419. A new type of electrometer. M. BOSSOLASCO AND F. MEDA. *Geofis. pura appl.*, **30**, *No.* 1, 151–4 (1955) In Italian.

A very simple valve-electrometer, operating with a dry-battery of 1·5 V only. The valve is used with inverted electrodes, while different cathode-resistances assure the automatic polarization. All the sensitivities necessary for the measurement of atmospheric electricity can be obtained. A.

551.510.535

8420. The observed polarization of high-frequency sky-wave signals at vertical incidence. M. G. MORGAN AND W. C. JOHNSON. *Physics of the ionosphere* [*Cambridge*] 74–7. See Abstr. 5763 (1955).

Description of consistent departures from the predictions of classical theory found for the polarization of waves at Hanover, New Hampshire, for frequencies from 2·8 Mc/s up to f_0F2. The most notable departures are in the axis ratios of the elliptic polarization loci and in the positions of the loci. G. M. BROWN

551.510.535

8421. Scattering of oblique incidence from ionospheric irregularities. D. K. BAILEY [Reported by J. A. Ratcliffe]. *Physics of the ionosphere* [*Cambridge*] 99–100. See Abstr. 5763 (1955).

Waves of detectable power can be transmitted from a sender of power about 30 kW over distances ~1 200 km on frequencies ~50 Mc/s by forward scattering from ionospheric irregularities estimated to occur at a height of 75–80 km by day and 85–90 km by night. The scattered wave undergoes fading, shows regular diurnal and seasonal variations and varies during geomagnetic storms. The received power has been related to the frequency of transmission and to the plasma frequency of the ionization in which the scattering irregularities are embedded.

G. M. BROWN

551.510.535

8422. A note on the motion of a cylindrical irregularity in an ionized medium. P. C. CLEMMOW, M. A. JOHNSON AND K. WEEKES. *Physics of the ionosphere* [*Cambridge*] 136–9. See Abstr. 5763 (1955).

It is shown that in a homogeneous, infinite, unbounded, weakly ionized, neutral gas in the presence of uniform mutually perpendicular electric and magnetic fields there is a unique steady state solution for which a circular cylindrical irregularity with its axis parallel to the magnetic field persists in the gas without change of form. The solution requires the cylinder to move with a definite velocity and is contrary to the result of Martyn [Abstr. 1894 (1954)] who considered a cylindrical boundary at rest. G. M. BROWN

551.510.535

Radio-wave propagation in the ionosphere. *See also under* "Electromagnetic waves and oscillations." Decimal classification 538.566.3

551.510.535 : 523.164

8423. Radio star scintillations due to ionospheric focusing. J. L. PAWSEY. *Physics of the ionosphere* [*Cambridge*] 172–3. See Abstr. 5763 (1955).

A new type of scintillation of the radio star in Cygnus has been detected which cannot be attributed to scattering from a number of randomly distributed ionospheric irregularities, but appears to be due to a focusing effect of lens-like irregularities. The irregularities are elongated in directions which vary from time to time, and it is not yet possible to decide in which part of the ionosphere they exist. G. M. BROWN

551.510.535 : 621.396.11

8424. Some aspects of the rapid directional fluctuations of short radio waves reflected at the ionosphere. E. N. BRAMLEY. *Proc. Instn Elect. Engrs, Paper No.* 1713, publ. *Aug.*, 1954 (**102B**, 533–40, 550–3).

Republication, with discussion, of the paper abstracted in Abstr. 10684 (1954).

551.510.536

8425. Electrodynamics of the outer atmosphere. J. W. DUNGEY. *Physics of the ionosphere* [*Cambridge*] 229–36. See Abstr. 5763 (1955).

The following considerations of the region of the atmosphere above the *F*-layer are treated: distribution of neutral and charged particles, ion density, outer boundary, Alfvén waves and the generation of waves at the outer surfaces by the flow of interplanetary gas. Observations of the zodiacal light and of the dispersion of whistlers as interpreted by Storey give some experimental data. G. M. BROWN

BIOLOGY 57/59

MEDICAL SCIENCE . HUMAN PHYSIOLOGY 61

611.08 : 611.12

8426. Multichannel recording apparatus for physiological studies. A. M. SCHER, A. C. YOUNG AND A. L. MALMGREN. *Rev. sci. Instrum.*, **26**, *No.* 6, 603–5 (*June*, 1955).

Apparatus used in a study of the pathway of the excitation of the heart is described. The multipolar electrode consists of fifteen fine (50-μ) tungsten wires staggered at 1·0 or ½mm intervals along a central shaft. Details of its construction are included. The electrode is used in conjunction with a sixteen-channel oscilloscope which permits recording from all terminals simultaneously. One channel is used for a time reference potential and one for a conventional electrocardiographic lead. A continuously variable circuit triggers the sweep. The delay is triggered by one heartbeat so that the depolarization of the heart during the next beat appears on the oscilloscope. Time signals are fed into all channels from a single oscillator. Circuit and schematic diagrams and experimental results are presented. A.

612.843.31

8427. Theory of color vision. R. A. HOUSTOUN. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 589–92 (*Aug.*, 1955).

The three variables of the Young–Helmholtz theory are replaced by I, s and σ, the area, position, and breadth of a probability distribution. As far as colour mixing is concerned, the theory is equivalent to the Young–Helmholtz theory. It leads to the result that the spectrum locus on the chromaticity diagram should be a parabola and treats the shift from scotopic to photopic vision from a new standpoint. A.

621.843.31

8428. Color signal systems for the red-green color blind. An experimental test of the three-color signal system proposed by Judd. L. L. SLOAN AND A. HABEL. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 592–8 (*Aug.*, 1955).

An experimental investigation is made of Judd's proposed three-colour code for instrument panel lights. The adequacy of these specifications is tested using both normal and colour-deficient subjects. It is shown that if certain specific limiting conditions are met as to the luminance, subtense, and chromaticity of the light signals, all normal observers and a majority of colour-deficient observers can make the necessary identifications. The possible explanations for the poor performance of some, but not all, protanopes are discussed. A.

612.843.31

8429. Recognition of red and green point sources by color-deficient observers. L. L. SLOAN AND A. HABEL. *J. Opt. Soc. Amer.*, **45**, *No.* 8, 599–601 (*Aug.*, 1955).

Determinations are made of the minimal intensities in mile-candles at which colour-deficient observers could distinguish red and green point sources falling within or just outside the chromaticity limits proposed by Judd. For colours within these limits the minimal intensities are closely related to scores on the Air Forces Color Threshold Test. When slightly yellower greens are included the task is more difficult for the colour-deficient observer. A.

612.858.74

8430. Theory for pitches 19, 15, and 11 plus a rumbling resulting from "sin 19x + sin 15x." M. F. MEYER. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 749–51 (*July*, 1955).

An old and revived graphical method is applied to the hydraulic theory of cochlear mechanics. A.

612.858.74

8431. Some parameters influencing the pitch of amplitude modulated signals. A. M. SMALL, JR. *J. Acoust. Soc. Amer.*, **27**, *No.* 6, 751–61 (*July*, 1955).

The rise-fall time, duty cycle and carrier frequency of a pulsed tone were systematically varied. Listeners matched the pitch of this signal to that of a sinusoidal comparison tone. Low SPL was used throughout. Two pitches were identified, one corresponding to the repetition rate (periodicity pitch), and the other to the carrier frequency (carrier pitch). The periodicity pitch decreased in audibility with the increase of any of the experimental variables. These variables had the opposite effect on the perception of the carrier

pitch, which in general was audible only at the longer duty cycles. Individual listeners varied considerably in their ability to match the pitch of the pulsed tones. Comparison of the results obtained with pulsed sinusoids to those of pulsed noise suggest that the perception of a periodicity pitch depends upon the bandwidth and spectral location of the pulsed signal's frequency components as well as envelope wave-form fluctuation. A.

612.858.76

8432. Spread of perstimulatory fatigue of a pure tone to neighboring frequencies. E. J. THWING. *J. Acoust. Soc. Amer.*, **27**, *No.* 4, 741–9 (*July*, 1955).

When a fatiguing tone is presented to one ear of an observer, and, after a period of time, a comparison tone of the same frequency is also presented to the other ear, the intensity of an equally-loud comparison tone is considerably less than the intensity of the fatiguing tone. This phenomenon has been referred to as perstimulatory fatigue. The present investigation was designed to determine the extent to which the perstimulatory fatigue induced by a pure tone spreads to neighbouring frequencies. Perstimulatory fatigue was measured by means of a series of simultaneous dichotic loudness balances made prior to, during, and subsequent to stimulation by a fatiguing tone of 1 000 c/s at a SPL of 80 db. Test tones were the same in sound pressure as the fatiguing stimulus. When measuring fatigue at a frequency other than that of the fatiguing tone, the fatiguing stimulus was turned off for a 15 sec interval. During this interval, a loudness balance was made at the frequency of the test tone. The findings demonstrate that maximum fatigue is produced at the frequency of the fatiguing stimulus. Fatigue falls off rapidly on both sides of this frequency at a negatively accelerated rate until at 100 c/s and at 2 500 c/s little or no effect is evident. The gradients of perstimulatory fatigue are nearly symmetrical when plotted on a log-frequency scale. A.

TECHNIQUE. MATERIALS 62/69

66.07

8433. Constant flow-rate circulating system. I. SHAPIRO AND H. LANDESMAN. *Rev. sci. Instrum.*, **26**, *No.* 7, 652–4 (*July*, 1955).

A circulating pump designed to give a constant rate of flow of gases, even at sub-atmospheric pressures, is described. The pumping mechanism consists of a reciprocating piston in a cylinder driven at a constant linear speed. The valves in a double-acting valve system have been made "weightless" by the use of solenoids. Mercury is used as a displacement fluid. A.

PHOTOGRAPHY 77

778.34 : 539.163.1

On a new method for study of radioactive phenomena: cinenucleography. Application to measurement of the period of radium C′. *See Abstr.* 8186

778.34 : 539.185.08

A slide rule technique for calculating neutron energies from tracks in nuclear emulsions. *See Abstr.* 8301

778.37 : 532.5

8434. High-speed photography in the study of moving fluids. R. P. FRASER AND N. DOMBROWSKI. *Royal Photographic Society International Conference* [*London*] 360–70. See Abstr. 7586 (1955).

Outlines the techniques and contains references and photographs on: (*a*) sheets of liquid in the process of disintegration showing the influence of liquid properties on the manner of disintegration, taken during a study of the mechanics of spray nozzles; (*b*) supersonic jet streams of air travelling at Mach 3 and 4, taken during a study of the flow in supersonic nozzles; (*c*) the detonation wave in gases, taken during a study of the spinning detonation wave in tubes. A.

778.37 : 533.6.011

8435. Schlieren methods for photographing high-speed air flows. D. W. HOLDER AND R. J. NORTH. *Royal Photographic Society International Conference* [*London*] 371–6. See Abstr. 7586 (1955).

Schlieren and direct-shadow methods are used to visualize changes of refractive index in an air flow, such as in shock waves which occur when the speed is high; they have, therefore, been used extensively in investigations related to the design of aircraft and projectiles. The paper describes several schlieren and shadow methods which have been found particularly valuable in this work, and includes details of the light sources and photographic techniques used at the N.P.L. and elsewhere. A.